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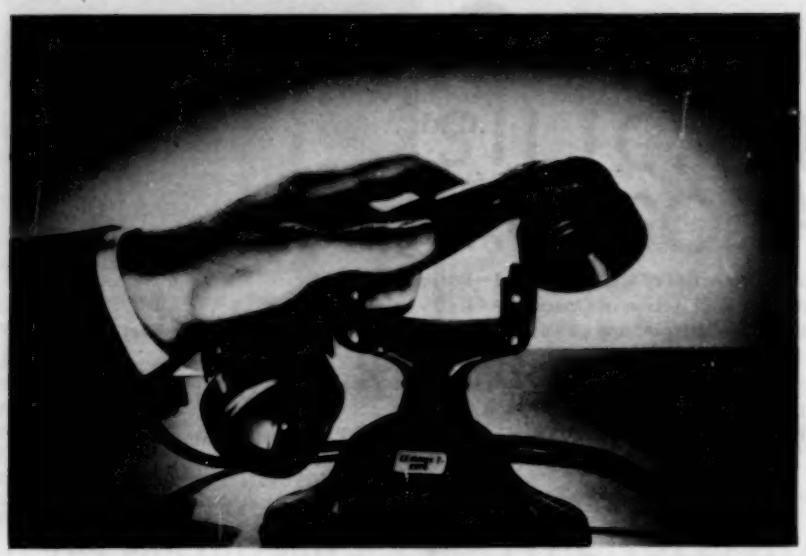

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SOME PROPERTIES OF CHROME SPINEL[1]

By C. W. Parmelee and Abde Ally

ABSTRACT

Five chrome ores covering a wide range of chemical composition from different localities were studied and their behavior at high temperatures was ascertained. The properties determined are chemical and mineralogical composition, thermal expansion (25 to 1250°C), specific gravity changes after various heat treatments, and X-ray characteristics.

I. Introduction

Different industries demand chrome ore of certain grade and quality. Refractories manufacturers require an ore low in silica. According to J. S. McDowell, an ore with 5% silica is allowed and from 5 to 9% is generally penalized; an ore above 9% silica is rejected. A chromium oxide content of 31 to 48% is acceptable to the ceramic industry.

Aside from chemical composition, which is purely an index of the refractoriness of the ore, the mineralogical composition is the deciding factor for its use in the refractories industry.[2] Certain physical characteristics are considered essential before the ore can be used in the latter industry. For instance, a "sandy" ore despite its chemical composition is considered undesirable for refractories, while a dense ore is said to make satisfactory brick.

Most studies of chromite have been concerned with the properties of chromite brick. The results of the investigators, however, are not in good agreement. This is illustrated in a fashion by the thermal expansion curves in Fig. 1. The discrepancies are due to variations in the chemical compositions and to physical factors. For these reasons, five chrome ores ranging in composition from 33 to 53% Cr_2O_3 were studied and their properties compared with the results of other investigators.

II. Outline of the Investigation

The thermal expansions of five chromites were determined on both the raw and previously fired ores. The interferometer method was used for the natural ore over the temperature range from 25 to approximately 850°C. The micrometric method was employed for the ore pulverized, molded into rods, and heated to cone 18 (about 1500°C) and the expansion determinations were carried to 1250°C. Other properties of interest, such as refractoriness and porosity, were also ascertained. From the chemical analyses

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received January 2, 1932.

An investigation submitted to the Graduate School of the University of Illinois in 1930 in conformity with part of the requirements for the degree of Master of Science in Ceramic Engineering.

[2] G. E. Seil, *Ceram. Abs.*, 9 [3], 192 (1930).

of the ores a study of the ratios of RO_3 and R_2O_3 was made and their possible effect upon slag action is suggested. Specific gravity determinations were made on the natural ore and on the ore after firing to various temperatures. Mineralogical compositions were calculated from chemical analyses and the results tested by optical studies to determine the nature of the mineral impurities. X-ray diffraction patterns were obtained and the deviations in the lattice structure due to impurities were observed.

III. Review of Literature

(1) Thermal Expansion

By far the larger number of measurements on thermal expansion have been made on chrome brick instead of on the mineral chromite. Analyses of the specimens are mentioned but infrequently.

J. Kratzert[3] and Y. Tadokoro[4] employed indirect methods as mechanical and optical lever methods. Their results are in fair agreement as seen from Fig. 1. F. H. Norton[5] used a direct micrometric method on a commercial chrome brick and carried the expansion determinations to 1700°C. A trace of inversion is reported at 600°C and a tremendous increase in size at 1000°C. A contraction is observed at 1150°C which becomes very rapid after 1550°C.

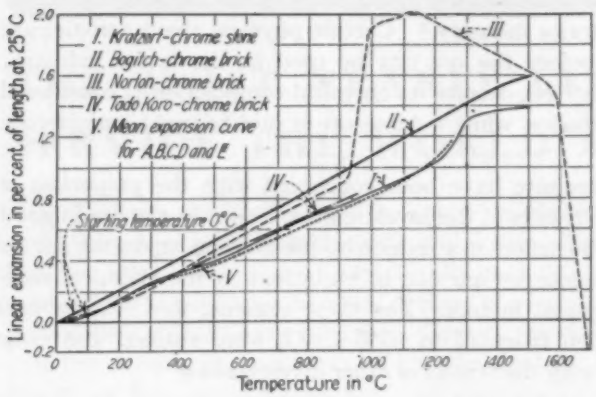

FIG. 1.—Thermal expansion of chrome ores and chrome brick.

The method used by B. Bogitch[6] is not stated. His expansion curves together with those of other investigators are plotted in Fig. 1 for comparison.

The analyses of chrome brick studied by Bogitch and Tadokoro are as follows:

---

[3] J. Kratzert and H. Immke, *Tonind.-Ztg.*, **51**, 417–22 (1927).

[4] Y. Tadokoro, Dept. of the Research Laboratory of the Imperial Iron Works, No. 2 (1921).

[5] F. H. Norton, "Thermal Expansion of Refractories," *Jour. Amer. Ceram. Soc.*, **8** [12], 799–815 (1925).

[6] B. Bogitch, *Compt. rend.*, **173**, 1358–60 (1921).

	Bogitch	Tadokoro
Cr_2O_3	50.23	32.89
SiO_2	5.15	8.30
FeO	9.44	
Fe_2O_3		16.91
MgO		16.48
CaO	(25.98)*	0.26
Al_2O_3	9.20	4.36

* Undetermined constituents.

(2) Chemical and Mineralogical Composition

A systematic study of chemical and mineral composition of chromite was made by Fisher.[7] From 150 published analyses of chrome ores, he made a ratio classification, purely chemical in nature. The collected analyses fall into the following prominent groups:

		Number of analyses	Per cent of total number of analyses
(I)	$FeO{\cdot}Al_2O_3{\cdot}Cr_2O_3$	12	8.0
(II)	$FeO{\cdot}MgO{\cdot}Al_2O_3{\cdot}Cr_2O_3$	96	64.0
(III)	$FeO{\cdot}MgO{\cdot}Fe_2O_3{\cdot}Al_2O_3{\cdot}Cr_2O_3$	31	20.6

None of these group averages approached the high Cr_2O_3 of the theoretical chromite. Considerable variation was found in the amounts of the oxides that enter both the acid and the base of chromite.

Fisher concludes that chromite as pure $FeO{\cdot}Cr_2O_3$ occurs only in meteorites. It is not a definite mineral and cannot be regarded as a member of a definite isomorphous series. Spinellids which make up chromite are interrelated. The simplest formula that may be used to express the mineral composition is 4 chromite plus 1 hercynite ($FeO{\cdot}Al_2O_3$). Chromite is usually a combination of the pure chromite molecule plus the so-called magnesio-chromite $(Fe{\cdot}Mg)O{\cdot}(Fe{\cdot}Al{\cdot}Cr)_2O_3$, hercynite ($FeO{\cdot}Al_2O_3$), and spinel ($MgO{\cdot}Al_2O_3$).

IV. Experimental Work

(1) Thermal Expansion

Two methods were employed for the determination of thermal expansion: (1) Pulfrich-Fizeau's method[8] was employed on the natural ore for the temperature interval of 25 to 850°C. (2) A micrometric method was used for the temperature range 25 to 1250°C on chromite rods fired to cone 18 in oxidizing atmosphere.

In the case of the micrometric method, curves obtained from two specimens of each sample were averaged graphically and the expansion coefficient of Tables I and II taken from the mean curves plotted in Figs. 1 and

[7] L. W. Fisher, *Amer. Mineralogist*, **14** [10], 341–57 (1929).
[8] G. E. Merritt, *Sci. Paper*, No. 485, Govt. Printing Office, Washington, D. C.

2A. For estimating the sampling error, four determinations were made on three specimens of sample D, one being a duplicate.

TABLE I

EXPANSION COEFFICIENT ($\times 10^{-6}$)

(Micrometer Method)

Temperature interval	A	B	C	D	E	Average
25–200°C	0.83	0.90	0.86	0.82	0.86	0.85
200–400°C	0.83	0.63	0.78	0.78	0.82	0.77
400–600°C	0.80	0.71	0.77	0.84	0.75	0.78
600–800°C	0.88	0.73	0.90	0.85	0.82	0.84
800–1000°C	0.92	0.76	0.93	0.95	0.95	0.90
1000–1250°C	1.68	1.58	1.2	1.12	1.62	1.44
25–1250°C	1.02	0.90	0.92	0.905	1.00	0.95
25–800°C	0.84	0.75	0.825	0.82	0.81	0.81
25–800°C Interferometer, unfired* sample	0.813			0.809	0.90	

* Values for B and C are omitted as duplicate tests made showed wide variations.

TABLE II

EXPANSION COEFFICIENT ($\times 10^{-6}$)

Temperature interval	Norton[5]	Kratzert[3]	Bogitch[4]	Tadokoro[1,6]	Average	Observed (av.)	Synthetic chromite
25–200°C	0.75	0.86	0.91	0.73	0.81	0.85	0.67
200–400°C	0.95	0.90	1.04	0.99	0.94	0.77	0.88
400–600°C	1.25	0.80	1.05	0.91	1.03	0.78	0.87
600–800°C	1.05	0.85	1.09	0.88	0.97	0.84	0.95
800–1000°C	5.5	0.95	1.15	0.85 (800–950)	2.11	0.90	0.94 (800–850)
1000–1250°C	0.0	1.5	1.12		0.87	1.44	
25–1250°C	1.46 (0–1250°C)	0.93	1.1		1.19	0.95	

* After 800, Tadokoro's values are not included in the average.

(2) Chemical Analysis and Mineralogical Composition

The five ores investigated were (A) Rhodesian African lump chrome ore, (B) Transvaal African lump chrome ore, (C) Cuban lump chrome ore, (D) Grecian lump chrome ore, and (E) a high-grade chrome ore obtained from Ward Natural Science Establishment, Rochester, N. Y. (source unknown).

Ores for which no analyses were given were analyzed by the junior author, using the standard method of the AMERICAN CERAMIC SOCIETY.[9]

In the ores, A, B, and D, for which only partial analyses were available, the undetermined oxide constituents were estimated in order to note roughly any obvious relationship between the chemical composition and certain physical properties. The estimations were based upon the typical analyses of the ores found in the localities whence the ores were obtained.

[9] "Methods of Chemical Analysis: Chrome Ores, and Chrome Brick," *Jour. Amer. Ceram. Soc.*, **11** [6], 361 (1928); "Standard Method for True Specific Gravity," *ibid.*, p. 453.

Some typical analyses of Rhodesian and Grecian chrome ores given by McDowell and Robertson[10] are as follows:

	Rhodesian ore (%)	Grecian ore (%)
Cr_2O_3	48.4	39.5
FeO	14.4	15.8
Al_2O_3	12.1	26.2
MgO	14.2	15.8
SiO_2	5.9	3.0
CaO		

The estimation of the undetermined oxides of samples A and D were mostly based upon these analyses. For sample B, estimates were based on Wagner's[11] work. In estimating oxide constituents, publications on the mineral resources of the United States[12] were also consulted. Table III gives the five analyses. Parentheses are placed around the figures which are estimated.

TABLE III

ANALYSES OF CHROME ORES

	A Rhodesian	B Transvaal	C Cuban	D Grecian	E
Cr_2O_3	47.14	42.68	33.83	37.74	53.08
SiO_2	7.75	3.34	3.11	6.09	5.11
FeO	(15.00)	(27.00)	13.07	(15.00)	14.00
CaO			Trace		2.59
MgO	(15.00)	(10.00)	17.61	(15.00)	8.95
Al_2O_3	(13.00)	(15.00)	31.11	(26.00)	16.11
Loss on ignition			1.12		

The following rules were observed in calculating the mineral analyses:

(1) All Cr_2O_3 or FeO was regarded as entering the chromite molecule.

(2) Silica was disposed of as magnesium olivine ($2MgO{\cdot}SiO_2$), serpentine ($2H_2O{\cdot}3MgO{\cdot}2SiO_2$), or as uvarovite ($3CaO{\cdot}Cr_2O_3{\cdot}3SiO_2$), microscopic study determining the choice.

(3) The remaining oxides were distributed to form the other members of the spinel series, $MgAl_2O_4$, $MgCr_2O_4$, and $FeAl_2O_4$. The excess of either acidic or basic oxides, which practically all of the chrome ore analyses indicate, were reported as such, periclase (MgO) and corundum (Al_2O_3).

(4) Ignition loss reported in the Cuban ore was regarded as CO_2 and was disposed of as magnesite ($MgCO_3$).

To calculate the mineral compositions, percentages of the various oxides were divided by their molecular weights and these were later combined to form different minerals. The average molecular weight used for theoretical density computation is calculated from the sum of the mols of various minerals contained in the 100 grams of the ore.

[10] J. S. McDowell and H. S. Robertson, "Chrome Ore Refractories," *Jour. Amer. Ceram. Soc.*, **5** [12], 865 (1922).

[11] Wagner, *Geol. Surv. Memoir*, No. 26, pp. 35–37, Dept. of Mines and Industries Union of South Africa.

[12] J. D. Diller, "Mineral Resources of the U.S.," Part 1, pp. 657–725 (1918).

(3) Specific Gravity and Porosity Specific gravity determinations were made on natural ores and on the ores heated to cone 3 (1150°C), cone 15 (1410°C), and cone 18 (about 1500°C). The temperatures selected represent the interesting points on the expansion curves obtained by Kratzert and Norton.

Determinations for porosity and specific gravity were made using the standard method of the AMERICAN CERAMIC SOCIETY.[9]

(4) Pyrometric Cone Equivalent None of the samples showed signs of vitrification at cone 37. Small pieces subjected to oxy-gas flame showed some sign of fusion on thin edges at about 2000 ± 50°C.

(5) X-Ray Data (*a*) Lattice dimensions (diffraction data) by the "powder method" were obtained from five chrome ores. The length of the edge of the unit cube, a_0, for the five ores given

TABLE IV

THE MOLAL MINERAL ANALYSES, THEORETICAL DENSITIES, AND TRUE SPECIFIC GRAVITIES OF THE CHROME ORES

	A Rhodesian	B Transvaal	C Cuban	D Grecian	E	Synthetic chromite
$FeO \cdot Cr_2O_3$ (chromite)	0.2089	0.2808	0.1821	0.2090	0.1951	
$MgO \cdot Cr_2O_3$ (magnochromite)	0.1012		0.0404	0.0391	0.1384	
$MgO \cdot Al_2O_3$ (spinel)	0.0772	0.0515	0.2686	0.2421	0.0065	
$2MgO \cdot SiO_2$ (magnesium olivine)		0.0554	0.0513	0.1010	0.0386	
$2H_2O \cdot 3MgO \cdot 2SiO_2$ (serpentine)	0.0646					
$3CaO \cdot Cr_2O_3 \cdot 3SiO_2$ (uvarovite)					0.0154	
$MgCO_3$ (magnesite)			0.0254			
MgO (periclase)		0.0857				
Al_2O_3 (corundum)	0.0500		0.0359	0.0133	0.1511	
$FeO \cdot Al_2O_3$ (hercynite)		0.0952				
Total mols in 100 grams of ore	0.5019	0.5686	0.6037	0.6045	0.5451	
Average molecular weight	199.1	175.8	165.6	165.3	183.3	
Theoretical density	4.619	4.145	3.989	3.934	4.245	5.085
True specific gravity	4.421	3.913	3.980	3.888	4.191	4.998
Difference between theoretical and actual densities (%)	4.79	5.93	0.226	1.18	1.29	1.74

in Table VII was calculated from the two following equations of the X-ray spectroscopy:

$$\frac{d}{n} = \frac{\lambda}{2 \operatorname{Sin} \theta} \tag{1}$$

$$a_0 = \frac{d_{hkl}}{n}\sqrt{(h^2 + k^2 + l^2)n^2} \tag{2}$$

(*b*) Theoretical densities of the ores were computed by employing the well-known relation

$$\rho = \frac{nM}{a_0^3}$$

in which ρ is density; n, the number of molecules per unit cell (8 in the case of spinels); M is the absolute mass of the molecule (equal to 1.649×10^{24} of the molecular weight).

To calculate M, chromite is regarded as consisting of a single kind of crystal of an isomorphous mixture of spinels. Its value is determined from the mineral analysis of the ore (Table IV).

Taking the case of the chrome ore C, for instance, 0.6037 (Table IV) is

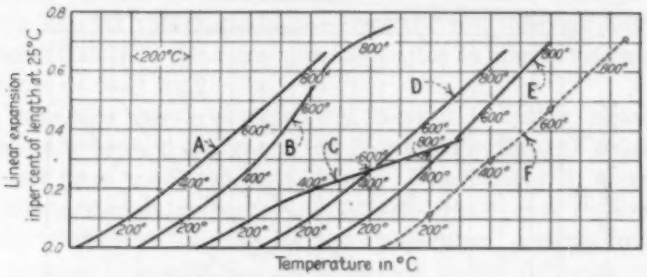

FIG. 2.—Thermal expansion of chromite (*A*, *B*, *C*, *D*, and *E*) (interferometer method). *F* = synthetic chromite.

the combined mols of the different minerals present in the 100 grams of the ore. Therefore, the average molecular weight of the ore is

$$\frac{100}{0.6037} = 165.6 = M$$

The density is

$$\rho = \frac{nM}{a_0^3} = \frac{8 \times 165.6 \times 1.649 \times 10^{-24}}{(8.179 \times 10^{-8})^3} = 3.989$$

V. Results

(1) Thermal Expansion

(*a*) The results by use of the interferometer method shown in Fig. 2, together with the expansion of synthetic chromite,[13] indicate discrepancies, as compared with the micrometric method, which in some cases were due to the presence of visible impurities in the material. In the small test pieces these were of sufficient size or amount to produce erratic expansion characteristics.

[13] An investigation on the synthetic spinels has recently been completed at the Department of Ceramic Engineering, University of Illinois. The unpublished data on the expansion of the synthetic $FeCr_2O_4$ and some other artificial spinels have been obtained from that source.

(*b*) Tests on pulverized and bonded (gum tragacanth) material were made by the micrometric method. Expansions were found practically reversible during the temperature interval 25 to 1250°C. The duplicates agreed fairly closely. Table I gives interval expansion coefficients calculated from the average of duplicates for each ore plotted in Fig. 2A. A mean of these values was taken for each interval for the five samples, each being given an equal weight. It furnished the data for making the mean expansion curve shown in Fig. 2A. It is evident from the curve that there is a marked increase in the rate of expansion after 1000°C and, as the spalling tendency of a brick depends upon its coefficient of expansion (other

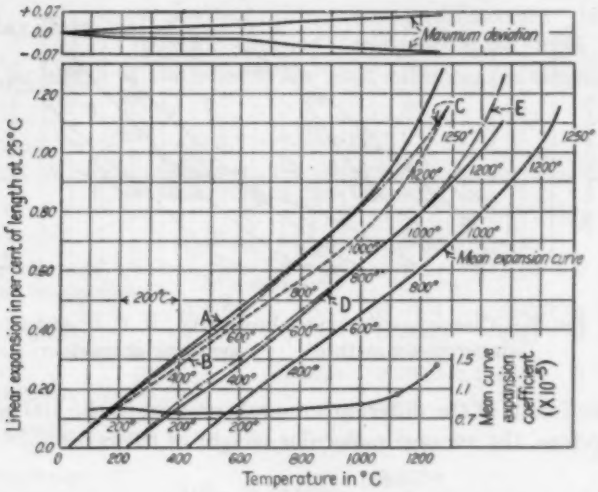

FIG. 2A.—Thermal expansion of chromite (micrometric method). The temperatures shown on the abscissa refer to the mean expansion coefficient curve whose ordinates are given on the right hand side.

things being equal) which in turn varies with the temperature, the chrome brick should exhibit increased tendency to spall after 1000°C.

The mean expansion curve of Fig. 2 is useful in designing when no information regarding the properties of chrome brick to be used for furnace lining is available. However, when certain properties of the brick, *e.g.*, chemical composition, are known, allowance should be made for the predominance of aluminates, chromites, and ferrites, as is indicated in the section "Chemical Analyses and Mineral Composition" (p. 221).

Maximum deviation plotted with the thermal expansion curve (Fig. 2A) gives the range within which fall the expansion curves of Tadokoro, Kratzert, and all the samples studied in this investigation.

The equation for the mean expansion curve is given by the following equalities:

$$25 \text{ to } 500°C, \log E = 0.00154T - 1.132$$
$$500 \text{ to } 1250°C, \log E = 0.00062T - 0.713$$

Where E = % expansion
T = temperature °C.

(*c*) Expansion coefficient values given in Table II are those calculated from the curves from the published work of four investigators. The values on the whole seem to be slightly higher than the values obtained in the present study. Several differences should be noted in this connection. (1) Three of the four curves represent expansion of chromite brick instead of chrome ore. (2) In the European countries a binder is usually employed. Bogitch's interval values are higher than the rest, disregarding Norton's inversion at 1000°C. This may possibly be due to lime or magnesite added as binder.[10]

The expansion curve obtained by Norton is rather unusual. The analysis of the brick is not given, but Norton is inclined to think that the commercial brick used was high in iron. The sample B, however, containing the maximum amount of iron (27.00% FeO), gave the lowest mean expansion of the five samples for the temperature interval investigated. These apparent discrepancies are explained in the following section on "Chemical Analysis."

Kratzert experimented on natural chromite and his values approach more closely the average of values obtained in the present study.[14]

(2) Chemical Analyses and the Mineral Composition

Table III gives the chemical analyses of the chrome ores and Table IV, their mineral analyses together with theoretical and actual densities.

If a ratio calculation of $R_2'''O_3$ to $R''O$ is made from the mineral analyses, disposing SiO_2, CaO, and the volatile matter (which do not enter into the composition of the isomorphous spinellids), as magnesium olivine ($2MgO \cdot SiO_2$), serpentine ($2H_2O \cdot 3MgO \cdot 2SiO_2$), uvarovite ($3CaO \cdot Cr_2O_3 \cdot 3SiO_2$), and magnesite ($MgCO_3$), the following table is obtained:

TABLE V

RATIO OF $R_2'''O_3$:$R''O$

Molal amounts

A	B	C	D	E
1:0.781	1:0.713	1:0.872	1:0.948	1:0.529

[14] Since the completion of this investigation, additional work has been done on the expansions of chromite by the Bureau of Standards (Bur. Stand., *Tech. News Bull.*, No. 158, p. 55 (1930)) and more recently by J. B. Austin (*Jour. Amer. Ceram. Soc.*, **14** [11], 795–810 (1931)).

The molal ratios in Table V, it should be noted, are all subnormal. On the other hand, there are a great many analyses known where the ratio R_2O_3:RO has been found to be abnormal,[7] the highest abnormal ratio reported being 1:3.69. It is apparent that the molal ratios are not dependent upon the chemical compositions of the ore or upon any of its constituents such as Cr_2O_3 or SiO_2, which are generally taken as an index of quality or of neutrality of chrome ore. It seems that chrome brick made from the ores with abnormal or subnormal ratio should respond differently in their performance and their resistance to slag action, regardless of Cr_2O_3 or SiO_2 content. No studies have been made in this connection.

The relation between the chemical and the mineralogical compositions and the thermal expansions is explained as follows: Aside from the manganese spinels, which are often present in small quantities, the simple spinellids that form the isomorphous mixture of chromite and their per cent expansions between the range 25 to 850°C are as follows:[13]

Synthetic spinels	Per cent expansion of length at 25°C
$FeCr_2O_4$	0.705
$MgCr_2O_4$	0.745
$FeAl_2O_4$	0.740
$MgAl_2O_4$	0.662
$FeFe_2O_4$	1.261
$MgFe_2O_4$	1.058

The expansions of the above spinellids and other members indicate that the chromites are generally intermediate in expansion between the higher ferrite values and the lower aluminate values, $FeCr_2O_4$ being an exception.

Therefore, when either the aluminates, chromites, or ferrites predominate in the ores, some allowance should be made in the mean expansion curve in Fig. 2A.

Norton's expansion values (Fig. 1) are unusually high, while sample B has the lowest expansion values of the five samples investigated. Both are rich in iron. This discrepancy can be explained by assuming that the iron in sample B is present in ferrous form, such as $FeCr_2O_4$ and $FeAl_2O_4$, while a good share of iron in Norton's sample is present as ferrites, $FeFe_2O_4$ and $MgFe_2O_4$ along with $FeCr_2O_4$. Two facts suggest this explanation: (1) All of the known ferrites are ferromagnetic except zinc, which seldom occurs in chromite, and sample B is nonmagnetic. (2) The expansion study of magnetite shows an inversion at the Curie point (magnetic inversion) at 588°C and there is considerable increase in expansion above 900°C. Norton reports a trace of inversion at 600°C and tremendous increase in expansion around 950°C.

(3) Specific Gravity Table VI gives the average of duplicates of specific gravity determination at different temperatures. These are plotted in Fig. 3.

From room temperature determinations it is evident that the true specific gravity is not a reliable method of ascertaining the quality of the ore. High chrome ores gave higher specific gravity values but not proportionate to chromium oxide content.

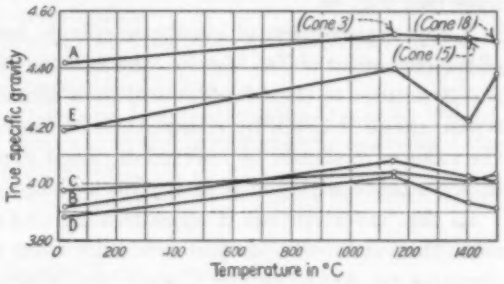

FIG. 3.—Specific gravity changes of chrome ores with temperature.

In all cases the specific gravity of heated ores is higher than that of natural ores. The increase in specific gravity, however, is not uniform with the temperature. Of the different temperatures at which the determinations were made density is found maximum in all cases at 1150°C (cone 3).

TABLE VI

TRUE SPECIFIC GRAVITY ($D^{30}/_{30}$) AND POROSITY

	A	B	C	D	E
Natural ore	4.421	3.913	3.980	3.888	4.191
Cone 3 (1150°C)	4.524	4.084	4.040	4.030	4.402
Cone 15 (1410°C)	4.501	4.027	4.013	3.938	4.217
Cone 18 (1560°C)	4.497	4.011	4.032	3.114	4.381
Apparent porosity (cone 18) (%)	35.95	26.70	35.20	33.50	30.36

The relation between the thermal expansion and specific gravity is shown by the fact that mean expansion coefficient values during 25 to 1250°C decrease with the decrease in specific gravity of the ores determined at the room temperature. The decrease, however, is not proportionate. A minor exception is D which deviates very slightly.

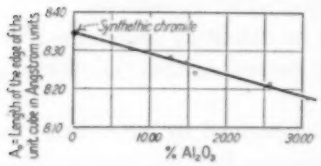

FIG. 4.—The relation between Al_2O_3 and A_0 equals the length of the edge of the unit cubes of the chrome ores *A*, *B*, *C*, *D*, *E*, and the synthetic chromite. (A_0 is read as a_0 in text.)

(4) Porosity No apparent correlation of porosity with expansion was observed. Sample A, which had the highest porosity, also had the lowest expansion. Samples D and E, however, do not have porosities corresponding to their expansions.

(5) X-Ray Data[15] The results seem to indicate that the values of a_0 for the different ores are inversely proportional to the

[15] G. L. Clark and Abde Ally, *Amer. Mineralogist*, **17** [2], 66–74 (1932).

Al_2O_3 content; the higher the amount of aluminates present in the isomorphous mixture of spinels, the lower is the length of the edge of the unit cube (see Fig. 4).

X-ray examination of synthetic spinels had shown that the structures of the chromites of Zn, Mg, Fe, and Mn are generally intermediate between the structures of their ferrites and their aluminates.[16] Therefore, with the replacement of Cr_2O_3 by either Al_2O_3 or Fe_2O_3 from the chromite molecule, the value of a_0 should be lowered or raised in proportion to the replacement, in accordance with the additive law of Vegard.

In this investigation it appears that Cr_2O_3 is replaced by Al_2O_3 alone, since the values of a_0 decline gradually from the synthetic chromite, which contains no Al_2O_3, to the Cuban ore, which contains 31% Al_2O_3. This seems to be further substantiated by the fact that the five ores examined are nonmagnetic, while all of the known ferrites except $ZnFe_2O_4$ are ferromagnetic and zinc seldom occurs in chromite.

TABLE VII

LATTICE DIMENSIONS OF THE CHROME ORES

(In Angstrom Units)

Synthetic chromite	A Rhodesian	B Transvaal	E	D Grecian	C Cuban	Ural*	Hungarian†
8.344 ±	8.283 ±	8.267 ±	8.241 ±	8.216 ±	8.179 ±	8.355 ± 0.004	8.05
0.003	0.001	0.001	0.001	0.001	0.002	8.358 ± 0.004	

* S. Holgersson, Lund Univ. Arsskrift, N. F. Avd., **2**, 23, 9; *Chem. Zentr.*, **1**, 372 (1929).

† L. Todoky, Budapest, *Z. Krist.*, **67**, 338-39 (1928).

Todoky's value of 8.05 Å (Table VII) appears to be low considering the fact that it is a high-grade chrome ore as revealed by its analysis.

The purity of the ore, it is evident, cannot be definitely ascertained by means of X-ray examination; it can be roughly surmised, however, as to its Al_2O_3 content.

The theoretical densities of the five ores, determined by extending the method which is generally applicable to substances forming isomorphous mixtures and continuous substitutional solid solutions which obey the additive law of Vegard, had a maximum difference of 1.3% between the theoretical and actual values in the case of the ores with complete analyses available and 5.93% where some of the undetermined constituents were estimated (Table IV).

VI. Conclusions

(1) Expansion curves of five chrome ores were found to be more or less uniform in the temperature range 25 to 1250°C.

[16] G. L. Clark, A. Ally, and A. E. Badger, *Amer. Jour. Sci.*, **22**, 539 (1931).

(2) There is a marked increase in expansion in all samples above 1000°C.

(3) The nonmagnetic nature of the ores suggests the presence of iron in the ferrous form in the ores investigated.

(4) Ores high in both Cr_2O_3 and SiO_2 tended to give high expansions.

(5) The ratios of $R_2'''O_3$:R''O of the five chrome ores were found to be all subnormal and varied from 1:0.948 to 1:0.529.

(6) There is a decrease in the mean expansion values between the interval 25 to 1250°C with the decrease in the initial specific gravities; the decrease, however, is not proportionate.

(7) There is an increase in specific gravity of the ore when heated, but the increase is not proportional to the temperature rise.

(8) The purity of the ore cannot be definitely ascertained by its specific gravity determination or by the X-ray examination.

(9) Lattice dimensions were inversely proportional to the Al_2O_3 content of the ores. The length of the edge of the unit cube varied from 8.283 ± 0.001 to 8.179 ± 0.002 Å.

(10) Theoretical densities computed by extending a method generally applicable to alloys of continuous substitutional types had a maximum difference of 1.3% between the theoretical and the actual values in the case of ores with complete analyses available and an optimum difference of 5.93% where some of the undetermined constituents were estimated.

Acknowledgment The authors wish to acknowledge the use of the X-ray equipment of the chemistry laboratory; the assistance of G. L. Clark and A. E. Badger in the interpretation of the data so obtained; the kindness of J. S. McDowell of the Harbison-Walker Refractories Company for samples of chrome ores; and F. H.Riddle of the Champion Porcelain Company for the dumortierite used for calibration purposes.

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FUNCTION AND ACTION OF OPACIFIERS[1]

By Leander R. Kirk

ABSTRACT

The causes of opacification and the function of opacifiers in white ware glazes are discussed briefly. The relative covering power of tin oxide is shown to be greater than that of zircon oxide under the same conditions. The fluidity of the glaze is affected by the amount of opacifier used and can be controlled in commercial practice by the use of a simple inclined testing block.

I. Introduction

In glazing ceramic ware opacification plays an important rôle. In general the purpose is to obscure the color of the basic material used, creating a vitreous white surface on an otherwise unattractive material. Thus iron and other metals and all varieties of off-color clayware are made available.

(1) Causes of Opacification Opacification results from (1) immaturity of fusion, the glaze being obviously underfired, (2) recrystallization of some component from the fused glass during the cooling process, and (3) insolubility at the maturing temperature of some of the original materials.

The first process is most unsatisfactory and dangerous as it results in dull surfaces which have a bad finish and texture and are apt to craze. The second process is widespread, but by no means general. It is used in the creation of mat and semimat glazes such as those used on wall tile and as the basis for the opacification in Bristol glazes used on stoneware. It is rather difficult, however, to control, and precludes to any degree a glossy finish to the glaze. By far the most satisfactory and accepted process is the third, by which a refractory white material is added to the glaze in comparatively small amounts, remaining undissolved during the fusion process and suspended in the glass after cooling.

(2) Opacifying Agents The substances available as opacifying agents are limited in number. Tin oxide has been used since the earliest times and antimony, zirconium, and titanium are also in use. Arsenic is satisfactory only on soft jewelry enamels. Cryolite and fluorspar are accessories but, with antimony, are limited to the lower temperatures of metal enameling as they give undesirable results at higher heats. Titanium has been used with some success but exhibits recrystallization tendencies and has an affinity for iron causing yellow discoloration which limits its value. For white ware fired at kiln temperatures ranging from cones 3 to 13, tin oxide and zirconium oxide are the only opacifiers available.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received September 4, 1931.

(3) Amount of Opacifier Required The amount of opacifier which must be added to a glaze to get maximum whiteness or covering power is determined by the nearness of the individual particles suspended in the glass. The closer the particles are together, the whiter the glaze becomes, until there is a solid screen of white particles in suspension masking the body underneath. Further increments upset the balance of the glaze without giving it any additional opacity.

Figure 1 shows an enlarged thin section of glaze and body in which the glaze is almost saturated. The particles of tin oxide show black in the photograph.

FIG. 1.

The amount of opacifier necessary for saturation also varies with the material used. Figure 2 shows the relative opacifying strength of tin oxide and zirconium oxide in the same glossy clear glaze. Both glazes on the left contain no opacifiers. The glaze on the upper right contains 10% tin oxide and the one on the lower right contains 10% zircon oxide; the intermediate points on both series represent variations of 2%. The photograph gives but a general idea of the relative power of the two materials. A visual inspection shows that the tin oxide reaches a saturation point between 4 and 6%, while zircon oxide reaches its optimum strength at 8% or more.

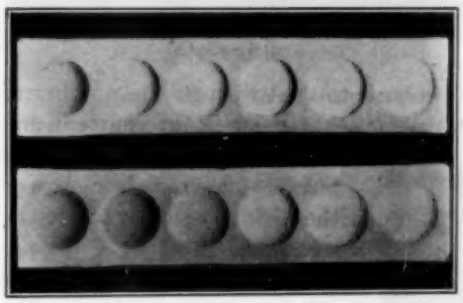

FIG. 2.—Upper, SnO_2, lower, ZrO_2.

II. Function of Opacifiers

(1) Colors The recent demand for colored glazes has resulted in a clearer understanding of the functions of opacifying materials. Lighter tints are best secured by adding the coloring materials to saturated white glaze. In enamels for metals this opacification can be secured by using a dense white frit rather than the more expensive metallic oxides. On the other hand, the deepest shades are best secured by a complete absence of any opacifiers, since it is not only more satisfactory but also more economical for the color to result from the inherent opacity of the coloring oxide alone. From these two

statements can be deduced the general statement that the amount of opacifiers should be inversely proportional to the depth of the color. This proposition will be found applicable to any type of glaze whether it be iron enamel, china, or porcelain. It applies, of course, only to glazes in which solid color is desired.

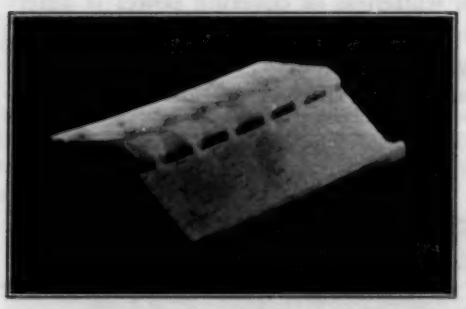

FIG. 3.

(2) Fluidity This addition or subtraction of opacifiers causes a wide variation in the action of the glaze and furthermore the coloring oxides themselves have characteristic fluxing or refractory qualities as the case may be. The opacifiers being of a more refractory nature invariably cause an increase in the viscosity of the glaze.

The glaze must not be so fluid that it runs off the ware, thus causing it to stick to the setter, to curtain on vertical sections, or to show light on the edges. Nor must it be so viscous that it is devoid of healing qualities.

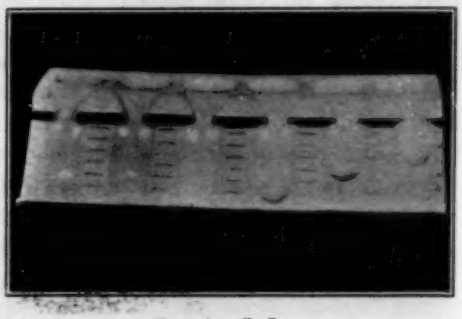

FIG. 4.—SnO_2.

In metal enameling this is not so hard to deal with as the number of fluxes available is numerous, and the fact that firing is intermittent and of short duration makes it possible to raise or lower the firing temperature or schedule.

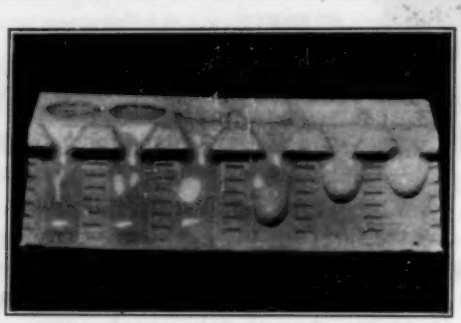

FIG. 5.—ZrO_2.

On white ware it is more satisfactory to adjust the viscosity of the glaze than to alter the firing. The relative viscosity at the maturing temperature can be easily determined by the use of a small inclined plane with slots in which the dry glaze can be packed before firing, as shown in Fig. 3. This viscosity testing piece is made of china and is bisqued

before using. It is $1^1/_2$ inches high by 6 inches long and has an incline of 45°, which angle was found most satisfactory after experimentation. In the top are circular depressions $^1/_8$ inch deep in which the dry glaze can be packed to see how it reacts in thick sections.

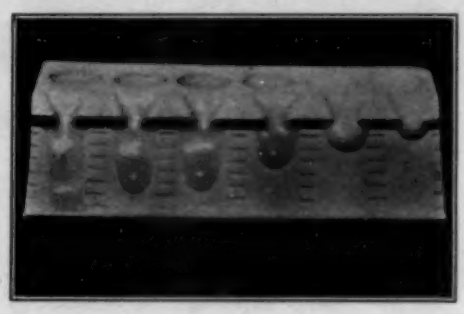

FIG. 6.

Figures 4 and 5 show how the viscosity of a glaze is affected by increments of tin oxide and zircon oxide, respectively. They belong to the same series of glazes that were shown in Fig. 2.

The approximate viscosity of a successful glaze in use must be determined and then all new glazes may be worked out to give the same flowing qualities.

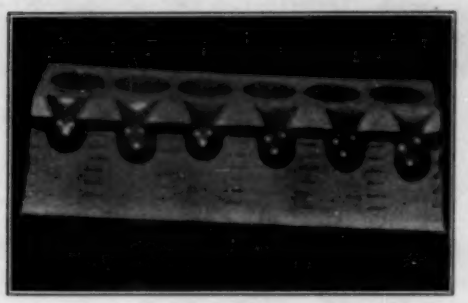

FIG. 7.

Figure 6 shows the effect of cutting down the amount of one of the fluxes in a glaze, resulting in an immature mat with a high viscosity and a tendency to craze. Any glaze with a tendency to craze or to be eggshell will immediately show up in the thick section on the top of the piece and sometimes on the incline.

Figure 7 shows a light-colored glaze in which the viscosity has been decreased giving it better flowing qualities by substituting a softer feldspar. As this was a light pink it was inadvisable to change the amount of opacifier on account of changing the color.

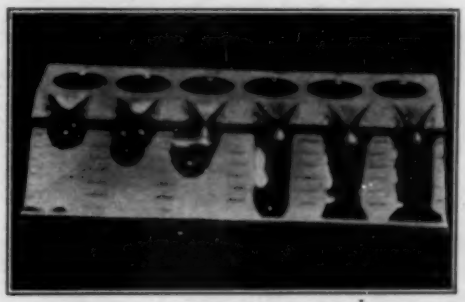

FIG. 8.

Figure 8 shows the effect on the viscosity of increasing the amount of coloring oxide. In this case it acted as a strong flux. The desired color was among those on the right but on account of its low

viscosity the glaze was unsatisfactory and had to be further adjusted. Figure 9 shows the effect of adding an opacifier to a glaze with approximately the right flowing qualities. Though it improved the color, it rendered it too viscous to be practical.

III. Conclusions

In both white and colored glazes, opacifiers are of primary importance. In the white ware field, tin oxide and zirconium oxide are the only materials which will give satisfactory results. Tin oxide has almost twice the covering power of zircon oxide and its use is advisable except where it gives deleterious effects.

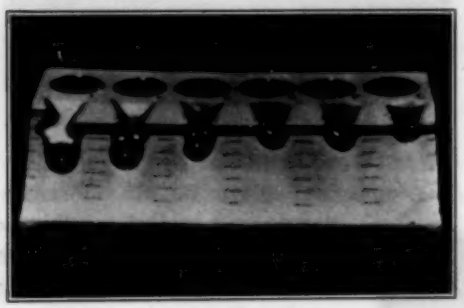

FIG. 9.

In colored glazes, the amount of opacifier should vary inversely as the depth of the color. In making pastel tints, for instance, the basic glaze should be saturated with opacifier, while in the deepest shades a clear basic glaze should be used.

As opacifiers and coloring oxides both cause a variation in the viscosity at the maturing temperature, the use of a simple incline testing piece is suggested to give consistently uniform results over a whole range of colors.

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THE EFFECT OF DE-AIRING ON THE STRENGTH OF STIFF-MUD PRODUCTS IN THE WET STATE[1]

By Ellis Lovejoy

ABSTRACT

The strength of one-inch square stiff-mud bars is determined by bending until they break and the angle of bending is determined as a measure of the wet strength.

I. Introduction

A series of tests is being made to develop a simple method of determining the wet strengths of stiff-mud products. In the course of this work some interesting results were obtained on the effect of vacuum.

The one-inch square bars for the tests were made under normal atmospheric and vacuum conditions through a small auger machine.[2] These bars were designated as "air" and "vacuum" bars.

II. Results

The results are shown in Fig. 1. The bar in the center is an air bar. These bars, of all clays thus far tested, crack sharply across the face in the bending and the crack runs quickly through the bar. An increase of 1 to 2 degrees in the bending after the crack across the face develops suffices to break the piece completely in two parts. Any one making structural clay products can easily determine this bending behavior by cutting a strip from the wall or web of a tile.

The behavior of the vacuum bar from the same clay and the same pug is seen at the left (Fig. 1). It has been bent to an angle of 180° without breaking and without even cracking across the face. The gaps in the top of the bend are on one side or the other and do not extend across the face. The extent of the stretching, approximating two inches, which is fully around the bend, should be noted.

The coil on the right is an exhibit only. If this is bent sharply the gaps are produced as seen in the bend of the inner coil. If it is bent less sharply, stretching over a considerable distance, the result is as seen in the bend of the second coil at the left. With a still larger bending radius the clay stretches with but slight visual evidence as seen in the bend of the third coil at the right.

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Structural Clay Products Division). Received December 2, 1931.

[2] For a description of the auger machine used in tests and for further results of the effect of de-airing on the strength of dry ware see paper by Ellis Lovejoy and H. E. CoVan, "Laboratory Equipment for Stiff-Mud Tests, Including Exhaustion of the Air," *Jour. Amer. Ceram. Soc.*, **14** [8], 533 (1931).

III. Tests with Different Clays

The tests to date have been made on Ohio Bedford shale, Florida kaolin, Indiana plastic fire clay, plastic Oklahoma shale, Maryland bond clay (shown in Fig. 1), Mississippi bond fire clay, and a low-plasticity Pennsylvania fire clay.

In all of these clays, the air bars break sharply at angles of less than 20° and as low as 8°. In the vacuum bars the Maryland, Mississippi, Indiana, and Oklahoma clays can be bent to 180° without breaking. Instead, they retain the major part of their resistance to bending.

The end-point of the air bars is easily determined and checks closely in series. It is difficult to fix any satisfactory end-point for the vacuum

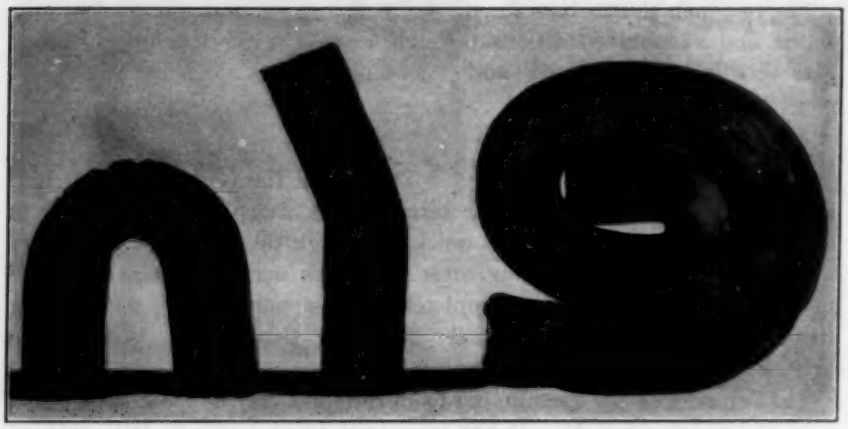

FIG. 1.

bars. For example, the Florida kaolin in the vacuum bars shows visible stretching around 60° bending. At 90° gaps are developing and become pronounced at 120°. Beyond this the bar offers little resistance to bending, yet it is not broken at 180°.

The Bedford shale in different samples has given the air bars breaking angles from 11 to 13°. The vacuum bars break at an angle around 65°.

The Pennsylvania weak fire clay in the air bars breaks at angles of 8 to 9°. In the vacuum bars it cracks around 20° and finally breaks around 28°. As previously noted the interval between cracking across the face and breaking in two pieces in the air bars is but 1 to 2°. In the vacuum bars the interval increases to 8°.

De-airing the clay increases the wet strength 200 to several hundred per cent.

The vacuum dry ware modulus of transverse rupture of the Florida

kaolin increases 86%; the Mississippi fire clay increases 49%; and the Pennsylvania fire clay, 28%.[2]

IV. Probable Effect of De-Airing on Drying

No tests have been made so far on the effect of de-airing on drying behavior. It seems reasonable to assume that, with the clay laminae in contact, the capillarity water movement from inside the ware to the outside will be continuous, which would not be the case with intercepting films of air. This condition plus great increase in strength should improve drying behavior.

STANDARD PYROMETRIC CONE COMPANY
COLUMBUS, OHIO

EXTRUSION OF REFRACTORY OXIDE INSULATORS FOR VACUUM TUBES[1]

By Louis Navias

ABSTRACT

A method is described whereby nonplastic materials such as refractory oxides are given a temporary plasticity, sufficient for extrusion. The organic plastic gel used consists of flour or starch paste with ammonia as an electrolyte. A short detailed account is given of the manufacture of twin-hole insulators made of MgO 98% and talc 2% for radio 227 vacuum tubes, with supplemental experimental results on other materials. The refractory oxides Al_2O_3, BeO, ZrO_2, MgO, and ThO_2 are compared from the standpoint of their physical properties and their ability to act as insulators in contact with hot tungsten filaments. Examples are given of the use of such extruded oxide insulators for hot filament supports.

I. Introduction

In 1927 the radio industry was developing receiving sets with vacuum tubes containing a heater element operated from alternating current. These alternating-current heaters are known as the oxide-coated type. Figure 1 gives a view of such a cathode heater. A hairpin tungsten filament is supported by a twin-hole insulator which in turn is partly covered by a nickel sleeve. The nickel sleeve on which is coated the alkaline-earth oxide compositions for electron emission is heated indirectly through the insulator by the filament operating on 2.5 volts. Examples of vacuum tubes using this type of heater are the UY-227 detector and amplifier and the UY-224 screen grid radio frequency amplifier. Both tubes have the special five-prong base. As the heating through of the cathode required about 20 to 30 seconds, it is now known as the "slow-heater" cathode, in contrast to the more recent "quick-heater" type requiring less than 10 seconds.

The materials available at that time for making these insulators were talc products, refractory clay insulators, porcelain, quartz glass, commercial alumina products, and possibly other materials. The size of the insulator required was 60 mils outside diameter, twin holes 10 to 11 mils diameter, uniformly spaced, and 22 or 23 millimeters long. The insulators were to be strong enough and straight enough to be pushed through the tubular nickel sleeves made by machine. During the vacuum-tube operation, the insulator must have sufficient resistance while hot to prevent electrical leakage between the two legs of the filament, and between the filament and the nickel sleeve. The heat conductivity through the insulator should be high. There should be little or no chemical reaction between the hot filament and the insulator; otherwise the life of the tube

[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Refractories Division). Received November 18, 1931.

would be short and the electron emission from the cathode would be low, giving a tube with low efficiency. It was a great disappointment to the radio industry to find that the insulator materials enumerated above, especially talc and porcelain products, with which it was acquainted, were not suited for the alternating-current tube. Little was known of the actual temperature of the filament and burn-out of the filament was common, due to melting and reaction of the insulator. As higher melting substances were employed, the melting of the insulator was avoided, but electric conduction was not materially decreased, nor the electron emission of the cathode increased.

The requirements of the problem were set as follows:

A pure oxide insulator, to be extruded without the aid of the plasticity imparted by clays in order to avoid the introduction of alkalis and alkaline earths, the oxide to have a high melting point and to be nonconducting electrically at 1500°C and higher. From the standpoint of quick and efficient exhaust of the vacuum tube, the insulator offers a drawback unless it is quite porous with easily accessible pores or unless it is completely solid. Of the stable oxides available then in commercial quantities with melting points above 2000°C were alumina 2050°C, zirconia 2687°C, magnesia 2800°C, and thoria 3050°C. As a matter of procedure the oxides with the highest melting points were given preference. Plasticity for extrusion was obtained from flour paste containing an electrolyte. The organic matter was removed in the firing. All firing of the oxides was done in reducing atmospheres, *i.e.*, in Mo- or W-wound furnaces protected by hydrogen and described in another paper.[2] Thoria and zirconia showed decided signs of reduction by color changes in firing and by erratic behavior as insulators in 227 vacuum tubes. Magnesia and alumina gave promising results and it was a question of choice between them. As magnesia had the higher melting point and in the process developed was the first oxide to be completely controlled, it was adopted for the insulators which were then manufactured on a commercial scale.

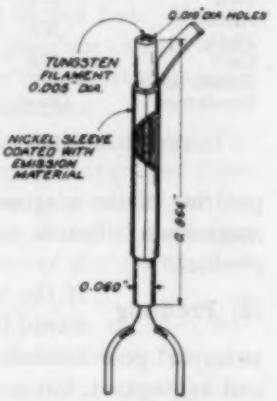

FIG. 1.—Alternating-current heater element for vacuum tubes.

A description will first be given of the process of making magnesia insulators for the 227 tube, with some of the experiments involved. This will be followed by a description of insulators made by extrusion from Al_2O_3, BeO, MgO, and ThO_2 for other vacuum tube purposes. As the processing of raw material, plastic agents, extrusion methods, and firing are essentially

[2] L. Navias, "Welded Zigzag Windings and Refractory Shapes for High-Temperature Furnaces," *Jour. Amer. Ceram. Soc.*, **14** [5], 365–75 (1931).

the same for all oxides and sizes of insulators, detailed description is given but once.

II. Manufacture of MgO 98%, Talc 2% Insulators

(1) MgO Raw Material Both U.S.P. and C.P. grades of magnesia were tried and used. Chemical analyses of impurities gave only an indication of whether a lot was suitable. The content of lime, alkalis, and soluble salts should be relatively low. Some chemical analyses of raw material are given in Table I. During the high

TABLE I

CHEMICAL ANALYSES OF MgO

Lot	1	4	6	7	10	9	8
Ignition loss	7.37%	nd	nd	2.87	7.30	7.58	7.87
SiO_2	Nil	0.60	0.10	tr.	0.52	1.19	0.51
Al_2O_3 }	Nil	0.20	0.06	0.12	0.03	0.06	0.07
Fe_2O_3 }	Nil	0.85	0.40	0.11	Nil	Nil	Nil
CaO	nd	nd	nd	nd	1.01	1.08	0.44
Soluble salts	Good	Poor	Good	Good	Good	Good	Good
Insulators							

NOTE: Remainder of constituents considered as MgO.

prefiring of the magnesia considerable impurities in the form of alkaline magnesium silicates and as alkalis were vaporized thus purifying the product.

(2) Prefiring If the impurity content were too high the prefired mass would be massive and stonelike and found by experience to impart poor insulation qualities. A normal prefired charge was shrunk and aggregated, but not sintered to a mass.

The prefiring was done in two stages, first in large porcelain or earthen containers to 1000°C in a muffle furnace, and second in a vertical hydrogen furnace to over 1600°C. The initial firing removes water vapor and carbon dioxide. The high temperature maintained for several hours shrinks the material and makes it dense. The product is crystalline, white in color, and has the properties of periclase. The progress made in the development of the insulator kept apace with the ability to prefire the magnesia thoroughly. As the prefiring was increased from 1300 to over 1600°C the control of the process became more effective, as will be shown later.

For the high firings, only "alundum" crucibles were available at that time and there was considerable reaction between the alkalis in the magnesia and the crucible material. Later, magnesia crucibles were made and successfully used. The ideal condition of firing magnesia in a crucible made of molybdenum sheet was found wanting, due to a blackening of the magnesia charge and to the presence of microscopic metallic spheres near the

crucible. This combination has been tried many times with identical results, and shows that under certain conditions there is chemical reduction of the magnesia material.

(3) Crushing and Grinding The fired charges were crushed in a hydraulic press, care being taken to avoid metal contamination, and then milled in porcelain with flint pebbles under standard conditions. The degree of firing and grinding with respect to the shrinkage of insulators made from a given lot of material was controlled by measuring the bulking figure (b.f.) of the powder taken from the mill. Two hundred grams of powder placed in a 500-cc. graduated cylinder (diameter $1^{13}/_{16}$ inches) were tapped on the bench for exactly two minutes. The powder packs in the vessel and assumes a volume which is fairly reproducible. This volume is the bulking figure. The dependence between bulking figure, flour paste content, and shrinkage is given later. It was so important that all milling products were subjected to this test. Due to the abrasiveness of the refractory the grinding in porcelain caused some contamination. This point was recognized and the best conditions were determined and used to yield the minimum contamination.

(4) Talc Addition To the finely ground MgO powder was added 2% talc of a high grade, and the mixture was ground three hours. The talc was added to give greater mechanical strength to the insulator, and in the quantity used did not affect the electrical insulation properties sufficiently to cause concern. A discussion of the use of other fluxes is given in the experimental part of the paper.

(5) Organic Plastic Agents (Flour Paste Gel) Considerable experimentation with organic materials indicated that but a few were suitable to the purpose at hand. The plastic agent finally used was made of flour 14%, water 79%, and concentrated ammonia 7%.

It is best prepared in a double boiler, as scorching and evaporation are avoided. The mixture is heated until the thin suspension is converted to a gel, which is allowed to cool. The gel does not develop its best plastic properties until it has stood at least 5 hours. Experiments were made with various electrolytes such as acids and bases to determine their effect upon the flour paste. These electrolytes help to maintain the water and flour constituents in the combined state, even upon applying pressure as is done in the extrusion operation. The adhesive qualities of the starch, gluten, and other constituents of the flour are developed by the addition of the ammonia. By the use of ammonia no alkalis are added as when alkali hydroxides are used. Acids attack the metal parts of the extrusion apparatus making them undesirable. Ammonia also acts as a preservative, preventing spoilage due to mold decomposition of the gel.

Where plasticity is needed without the full adhesiveness attained with

flour paste, a starch paste may be used. A representative batch would be cornstarch 10%, water 86%, and concentrated ammonia 4%.

The carbon content of either the flour paste or starch paste is readily disposed of by firing the insulators in a hydrogen atmosphere, volatile hydrocarbons being formed. The flour paste is readily oxidized in a gas-air furnace.

Assuming the formula $(C_6H_{10}O_5)_x$ for flour, the carbon content is 45%. In a paste containing 14% flour, there is 0.063 gram C per 1 gram of paste.

(6) Preparation of Plastic Mass The powder and flour paste gel may be mixed in a mortar with a pestle by hand or in a motor-driven dough machine. The mass is made plastic (not sticky) and in this condition it may be worked in the hand for quite a long period of time without drying. An experienced operator can gage by the

TABLE II

RELATIONSHIP BETWEEN BULKING FIGURE, PLASTICITY, PASTE ADDITION, AND FIRING SHRINKAGE

Bulking figure (cc./200 grams)	Addition of grams flour paste/100 grams MgO	Plasticity (penetration in mm.)	Extrusion through die (diam. in mils)	Fired insulator (diam. in mils)
97	29	21	66.5	59.5
97	29	22	66.5	59.5
108	34	21	66.5	58.7
108	35	23	66.5	58.7
125	42	21	67.5	57.7
125	42	21	67.5	57.7
125	43	22	67.5	57.7
145	47	19	67.5	57.2
145	48	22	67.5	57.2
145	46	21	67.5	57.2

"feel" quite accurately when sufficient gel has been added. To remove guesswork and errors, however, a plasticity test was used, based on the Vicat-LeChatelier cement setting apparatus. The plunger operating in a vertical direction was given a total load of 500 grams on the plunger diameter of exactly 1 centimeter. The plastic mass was held in a brass ring, 1 inch inside diameter and 1 inch high, with top and bottom smoothed off with a spatula. The plunger was let down slowly onto the mass and after exactly two minutes the penetration was read in millimeters. A penetration of around 20 millimeters or slightly less was considered necessary. A higher penetration indicative of larger paste content would give a good extrusion mixture, but the shrinkage of the insulators would be excessive in the firing. The relationship between bulking figure, flour paste additions, plasticity, and firing shrinkage may be seen from Table II.

In this series the plasticity remained constant and the flour paste required for the different lots varied considerably. The effect on firing shrinkage

may be seen by comparing the data in the last two columns. Material with a bulking figure above 110 was rejected and refired to greater density. Appropriately sized dies were used with the material having a b.f. below 110 to give fired insulators the diameter of 60 mils.

A b.f. of 145 is representative of material fired to (roughly) 1400°C, a b.f. of 125 to 1500°C, a b.f. of 108 to 1600°C, and a b.f. of 97 to about 1650°C.

(7) Extrusion Operation A sketch of an extrusion device is shown in Fig. 2, holding about 200 grams of powder with the necessary flour paste. It proved convenient for the size of insulator at hand. Smaller and larger devices are in use depending upon the quantity of production and the size of the insulator. By turning the screw the plunger forces the plastic mass through a number of large holes in the pinholder and into the space between the pins and the die proper. The pins extend slightly beyond the die to prevent collapse of the insulator as it issues from the die. In the early stages of production, pins were made of drill rod and dies of hardened steel. Due to the abrasiveness of the fired magnesia, a steel die increased in diameter from 66.5 to 67.5 mils after extruding 3000 grams of material. Then pins were made of tungsten wire and dies out of cemented tungstic carbide. Four such dies have been used, each extruding 100,000 grams of material, and they still measure below 67 mils, being made 66.5 mils. Another great inconvenience of the steel die was that it became tapered besides increasing in outlet diameter. Insulators coming through a tapered die swelled as they left the die. The dies were made as inserts and held in a die holder.

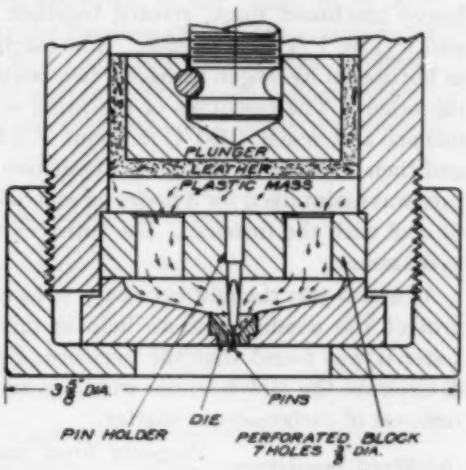

FIG. 2.—Extrusion apparatus.

The plastic column from the die was laid in angular grooves made in plaster blocks, and cut to the length of the block. The long lengths soon showed shrinkage at both ends of the block. Properly prepared material would not curl, crack, or roll. In an hour's time these lengths were dry and could be handled with ease.

They were then cut into lengths with a cutting device having a sharp razor-like cutter, applied against a rubber backing. The cutting was

accurate and the ends were neither ragged nor crushed. Linear drying and firing shrinkage varied with the makeup of the material; hence for each die size a corresponding "green" length was taken, as shown in these figures.

Die diameter (mils)	"Green" length (mm.)	Fired length (mm.)
64.0	23.0	22.0
65.5	23.5	22.0
66.5	24.0	22.0
67.5	25.0	22.0

(8) Firing Operation The cut "green" insulators were assembled by hand into piles in molybdenum boats, made of heavy machined stock, riveted together. The boats were 8 inches long and $1^1/_8$ by $1^1/_8$ inches inside. The carefully packed boats were then fired in horizontal hydrogen furnaces, two boats to a furnace, stoked one behind the other. The essentials of the firing schedule were to start from a cold furnace and reach 1000°C in about $2^1/_2$ hours, hold at 1000°C for 1 hour, and then advance to 1600°C in about two hours. The maximum temperature was maintained for 3 hours on each boat. The boats were then allowed to cool with the furnace. The furnaces were 24 inches long and 2 inches in diameter.

At first it was thought necessary to have hydrogen free of water vapor to protect the winding and to help in removing the carbonaceous matter. Later it was found that the presence of moisture in the hydrogen did not deteriorate the molybdenum windings and actually accelerated the rate of removal of carbonaceous matter.

(9) Fired Insulators (Properties) Properly fired magnesia insulators were always very white in color, straight, and strong. To test strength, insulators were broken in static transverse, the twin holes always lying in a horizontal plane and the load applied at right angles to this plane. The span was exactly $^5/_8$ inch and the load applied was mercury from a burette. A load of at least 500 grams was necessary to break a passable insulator. Assuming that the insulator was solid (that is without the twin holes) this would amount to a modulus of rupture of 8000 pounds per square inch. The later insulators of 23 millimeters length, 60 mils in diameter with two holes 10.5 mils in diameter each, weighed 9.3 grams per 100.

If the firing schedule was unduly hastened, dark colored insulators were obtained which could not always be fired white. Crooked and curved insulators resulted from excessive firing shrinkage, due to the use of material of high bulking figure.

Since only very straight insulators could be used due to the process of assembly, all insulators were tested for straightness by rolling them down

a lighted translucent plate glass. Scintillations on rolling indicated lack of straightness.

The top layer of each pile of magnesia insulators was rejected, for these insulators were coated with a layer of magnesia which easily flaked off. These insulators also were not as strong as the remainder. This top-layer surface condition has been found with all magnesia insulators irrespective of size, and is common to every lot of magnesia experimented with, including pure magnesia insulators. This condition is not found with other oxides.

Porosity measurements made on insulators of the same composition, MgO 98% and talc 2%, but of much larger size, gave a pore volume of 47%. Other insulators have shown porosities in the range 35 to 50%. Porosities may be varied by changing the grinding and the firing procedures.

Petrographic examination of the fired insulators showed them to consist of a group of small isotropic particles surrounded by a well-defined network of anisotropic material. The isotropic particles had a refractive index of

TABLE III

EFFECT OF REWORKING EXTRUSION SCRAP

Lot No.	Squirting scrap firing	Transverse strength (grams)	Life test	Emission
822	2nd	650	O. K.	Good
823	3rd	583	O. K.	Bad
842	2nd	608	O. K.	Fair
843	3rd	736	O. K.	Bad

1.736, and the anisotropic network a materially lower refractive index with low birefringence. The isotropic particles correspond to periclase (crystalline MgO). The network material enclosing a group of isotropic particles sometimes showed the same optical orientation, but different from the optical orientation of a neighboring network. The isotropic particles range in average size between 0.27 and 0.69 mil (0.007 to 0.018 mm.).

(10) Salvaging Scrap (1) Extrusion scrap refers to the material left in the extrusion device and all odds and ends of unfired material which has been mixed with paste. Such material is fired in the low prefiring furnace to 900 to 1000°C to burn out the organic matter. The powdered residue is mixed with fresh paste and extruded. Insulators made of this "1st squirting scrap" were found satisfactory in all respects, as were insulators made of "2nd squirting scrap." But insulators made of "3rd squirting scrap," while perfect in themselves when built into 227 tubes, caused low emission. It was assumed that impurities were accumulated with each additional process and that the limit had been reached on the third reworking, using emission of the tube as the criterion. Table III shows the effect of reworking scrap.

Attempts to salvage the rejected scrap by washing with water or other substances and by refiring at high temperatures were only partially successful. From an economic standpoint it was better to reject such material entirely.

(2) Fired insulators which were defective in dimensions were collected and ground alone in a ball mill. No talc was added because the material contained its proportion. Satisfactory insulators were made from this source of waste.

(11) Emission Requirements of the 227 Radio Tube An electron emission of 50 milliamperes was necessary for the proper operation of the tube. An emission of 50 to 80 milliamperes was considered fair, 80 to 100 milliamperes was good, and 100 and up was very good. No difficulty was experienced in maintaining good emission.

(12) Life Test of Tubes All changes in insulator compositions, dimensions, or makeup were followed by emission measurements and life tests. In the life tests, the filaments of the tubes were run at a 10% overvoltage, 2.75 volts, and intermittently on and off to determine behavior due to reaction between filament and insulator. Tubes have been run for 1500 hours in this way without burn-out failures.

(13) Insulators MgO 2% Talc (Lots 630–664) Insulators were taken from tubes given the life test of 1500 hours. The insulators were white except at the bottom where they were gray. The holes of the insulators were fairly round and uniform except toward the bottom where the legs of the filament tend to spread toward the supports. Here the holes were elliptical and rather dark, indicative of some reaction. The filaments were uniform in diameter throughout their length. From examination of these tubes and many other tubes of other design, there is ample evidence that a hot tungsten filament will vaporize the magnesia with which it comes in contact. By so receding, the magnesia prevents reaction to any great extent. Temperatures of 1800°C are sufficient to cause the vaporization of magnesia under these conditions.

III. Supplementary Experiments on Insulators for UY-227 Vacuum Tubes

(A) Experiments with Fluxes (see Table IV)

(1) Beryl Beryl gave good promise as a flux for strong insulators. They were, however, rough to the touch, unless the beryl was ground to pass through 300-mesh as in No. 776. Beryl melts to a glass around 1300°C.

(2) Calcium Silicate A melt of calcium silicate containing 60% SiO_2 and 40% CaO was used as flux. The insulators were white, uniform, and quite straight. Strength only average.

(3) Calcium Aluminate A composition 65% Al_2O_3 and 35% CaO, melted and ground, was tried as flux. With the ordinary grinding of both the magnesia and calcium aluminate, bloated insulators were obtained (as Nos. 749 and 750). On grinding the materials to pass 300-mesh, better distribution was obtained, and smooth desirable insulators resulted. Strength was good and good tube characteristics were obtained as in No. 788.

(4) China Clay An English china clay was used with success as a flux. Insulators with china clay were darker in color than the insulators with talc. With the ordinary grinding procedure, the

TABLE IV

FLUXES USED WITH MAGNESIA INSULATORS

Lot No.	Flux (%)	Talc (%)	Grinding mesh	Die diameter (mils)	Insulator diameter (mils)	Transverse strength (grams)	Emission	Life
757	Beryl 2		200	65.5	58.3	620		
758	Beryl 2	2	200	65.5	57.4	623		
759	Beryl 4		200	65.5	56.4	645		
776	Beryl 2		300	66.5	59.7	607		
746	Calcium silicate 2	1	200	66.5	58.8	445		
747	Calcium silicate 2		200	66.5	59.0	471		
749	Calcium aluminate 2	1	200	66.5	59.4	582	(Bloated)	
750	Calcium aluminate 2		200	66.5	62.4	262	(Bloated)	
788	Calcium aluminate 2		300	66.5	58.6	758	Good	Good
773	Clay 2		200	66.5	61.8	762	Good	Good
774	Clay 2	2	200	66.5	61.7	562		
775	Clay 4		200	66.5	59.6	670		
789	Clay 2		300	66.5	58.1	795	Good	Good
799	Clay 2		300	67.5	58.9	1106	Good	Good
800		2	300	66.5	58.1	739	Good	Good
769		2	200	66.5	59.7	580		
745		4	200	66.5	59.3	476	Fair	
768		4	300	66.5	57.0	679	Fair	

clay imparted a roughness to the surface of the insulator. On using finer material smooth insulators were obtained, with high strength, good emission, and long life. In No. 800 is indicated the effect of fine grinding with talc present as flux, greater strength and shrinkage being noted.

Lot No. 789 was unique in that the disturbance known as "hum" was less than usual. The "hum" is said to be due to an appreciable ripple voltage set up by the filament temperature following the variations in alternating current.

(5) Talc Content Variation Increasing the talc content from 2 to 4% yielded stronger insulators only if finer grinding was used. Greater shrinkage and warpage, however, were

also introduced. Insulators fired together in the boats ordinarily merely require a gentle tap to separate them. The higher talc content caused them to stick together quite badly. Emission was only fair for these insulators.

(B) Fused Magnesia

Fused magnesia taken from the center of a large ingot was tried. The chemical analysis furnished by the melting plant read MgO 97%, CaO 1%, SiO_2 1 to 1.5%, and Fe_2O_3 0.25%. Petrographic analysis showed besides isotropic periclase, a fair proportion of anisotropic material indicating compounds with the impurities. In the finely crushed material there is known to be present magnetic iron difficult to separate. The ground fused magnesia was mixed with 2% talc, and from the mixture insulators were made in the usual procedure. The insulators were quite glassy and dark. Repeated firings of one lot neither strengthened them nor made them lighter in color. Lot No. 751, made with a 66.5-mil die, gave insulators 57.0 mils in diameter, high transverse strength 776 grams, fair emission, and good life. Lot No. 770, ground to pass a 300-mesh sieve, gave a 59.2-mil insulator, fair strength 495 grams, good emission, and good life. It was surprising that the fused magnesia gave no lower shrinkage than the high-fired magnesia regularly used.

TABLE V

INSULATORS WITH 7.5-MIL TWIN HOLES

Lot No.	Die diameter (mils)	2 pins diameter (mils)	Fired Insulator	
			Outside diameter (mils)	Inside hole diameter (mils)
712	66.5	10	59.9	7.5
791	66.5	10	59.0	7.5
845	66.5	10	59.9	7.5
817	50.0	10	44.2	7.5

(C) Insulators with 7.5-Mil Twin Holes

Insulators were made with smaller twin holes by using smaller pins (Table V). By so doing vibration of the filament was lessened. One lot of insulators was made with 7.5-mil holes and with 44-mil outside diameter. With lot No. 817 insulators the vacuum tubes required about 15 seconds to reach the desired current flow, whereas with the larger insulators 20 to 30 seconds were required.

(D) 1500-Hour Intermittent Life Test Samples (227 Tubes)

A number of vacuum tubes which had been on life test for 1500 hours with the filament running on 2.75 volts (a 10% overvoltage) were examined.

(1) ThO_2, 3% Talc (No. 530) The insulator was pitted at the loop end of the filament. In the main, the holes of the insulator were round except at several places along the insulator where the material had receded on contact with hot filament. The filament was uniform in diameter except for a short distance on one leg where the tungsten was distinctly roughened by reaction.

(2) ThO_2, 3% Clay (No. 547) Pitting was in evidence between holes near the loop end of the filament. The inside surface of the twin holes was darkened throughout. Inner surface also showed recession of material at several places. Filament was slightly roughened at two spots.

(3) MgO, 2% Clay (No. 558) Two heaters of this lot were examined. The insulators were quite white, except where they had broken in the nickel sleeve. The holes were enlarged slightly at several places due to contact with the filament. One filament showed a slight reduction in diameter at a break in the insulator; otherwise the filaments were not reacted upon.

IV. Extruded Oxide Insulators for Vacuum Tubes

(1) Preparation of Insulators and Spacers The insulators mentioned in this section are made in the same way as the magnesia insulators described fully above, except that no fluxes of any kind are intentionally added. The preparation of the oxides by prefiring and grinding, the extrusion process, and the final firing process are all similar. The purest ThO_2 is obtained by heating the nitrate in air, the maximum temperature reached being 1300°C. The other substances are obtained as oxides. With large insulators such as tubes with thin walls, and especially tubes of the heavy thoria, it is necessary to use a fairly stiff plastic extrusion mass. The amounts of flour paste used with these oxides are about 30 grams paste per 100 grams oxide of Al_2O_3, BeO, and MgO, and 10 grams paste per 100 grams of ThO_2. The average bulking figures for the prepared oxides are Al_2O_3 100, BeO 110, MgO 100, and ThO_2 45 (cubic centimeters per 200 grams). The dried insulators cut into lengths of 6, 8, or 10 inches are fired in molybdenum boats to 1600°C and above. The carbon content of finished insulators has been determined by burning in oxygen and collecting the carbon dioxide. Values range between 0.03% C and zero, but chiefly around 0.01% C.

Rods have been made as small as 10 mils and as large as one inch in diameter. Tubes have been made with holes as small as 3 mils in diameter and as large as $^3/_4$ inch. Odd shapes have also found their usefulness, a few examples being shown in Fig. 3. The flat shape with six holes in a row was made by extruding the flat ribbon with holes and the small tubes separately. The small tubes were fired alone and then inserted into the

unfired flat piece. The combination was then fired, giving tight fitting end pieces.

From extruded rods and tubes many simple and complicated shapes have been machined and turned out to serve as spacers near and in contact with hot filaments. For experimental work especially, these spacers have proved of great value. Many hundreds of shapes have been made and the four oxides, Al_2O_3, BeO, MgO, and ThO_2 were used. It is easier to cut, machine, and drill these substances in the "green" state, allowing for firing shrinkage, and then to fire the completed pieces to over 1600°C. With the appropriate tools, however, the fired objects may also be worked. Where the refractory shapes are relatively short or narrow and when the quantity to be made is large enough to justify the expense, they may be made in metal molds and dies by the pressing operation.

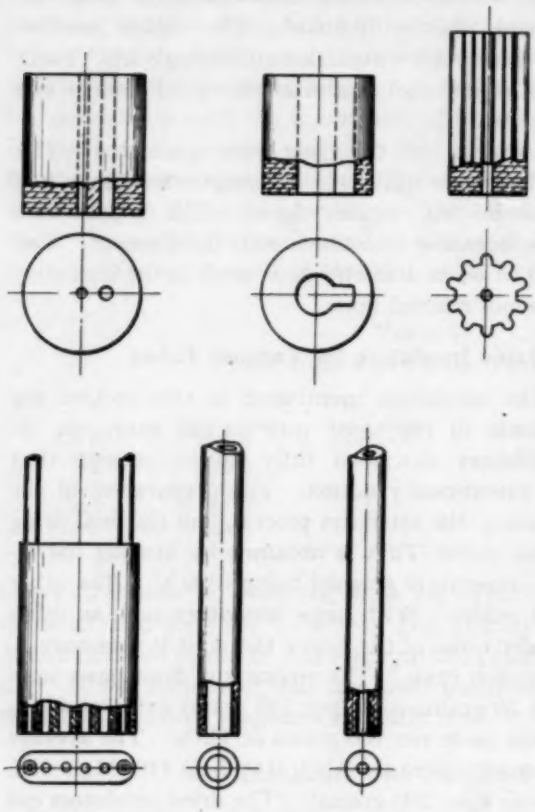

FIG. 3.—Extruded insulator shapes.

Wherever in a tube leads need insulation and are subject to heating, these oxide insulators are used. Their porous nature aids in the evacuation process. When the temperatures are low enough, silica glass, magnesium silicate products, and porcelains find many good uses in vacuum tubes.

As far as the author knows the only other extensive work on the extrusion of oxides was carried on in England. The National Physical Laboratory of England stated in its annual reports of 1925 and 1927 that one of its recent developments was the evolution of a process, whereby nonplastic materials could be extruded in the form of tubes and rods by incorporating with them a suitable organic binder or "dope" such as cellulose acetate

solution. In succeeding reports mention is made of an extrusion machine actuated by a hydraulic ram. Slightly more information on this English process is given by Donald Turner[3] in a recent paper on "Special Refractories for Metallurgical Research."

(2) Types of Hot Filaments

Figure 4 shows several types of filaments and their insulator supports or spacers. A fine coil of tungsten wire spirally wound on an alumina tube insulator is shown in Fig. 4(*a*). A filament of 2-mil wire carries 110 volts and 0.2 ampere. The return lead passes through the center of the insulator. Hence this insulator must withstand 110 volts between leads near the bottom, relatively the coolest part of the heater. The filament is usually covered with an alumina powder coating. Beryllia has also been used. Figure 4(*b*) illustrates a heavy filament 70 mils in diameter wound spirally on an alumina insulator. Such a filament will require 5 volts and 60 amperes to heat it. The molybdenum rod passing through the center of the tube acts as a support rod only. Often oxide insulators are used to house the ends of the tube insulator. Several sizes of this design with varying electrical requirements have been in use. A spiral filament of 25 mils in diameter supported centrally inside of an insulator tube made of magnesia or thoria is shown in Fig. 4(*c*). It requires 5 volts and 20 amperes to operate. The insulator prevents the closely wound spiral filament from coming in contact with the nickel cathode and helps to give uniform radiation. This class of heater is made in several sizes.

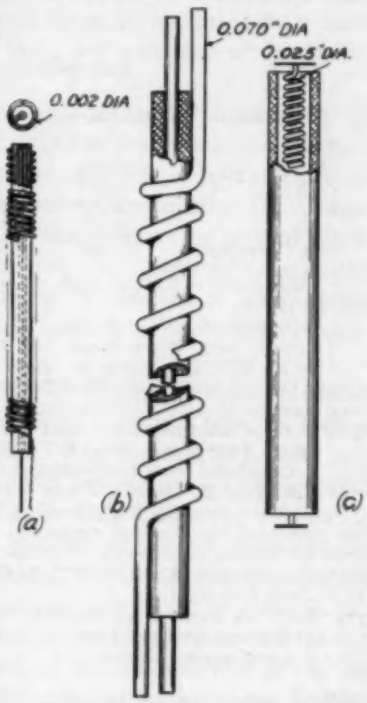

FIG. 4.—Filaments and insulator supports.

(3) Properties of Oxides and Their Reaction with Hot Filaments

Extruded oxide insulators are used as filament supports and filament spacers in quite a number of vacuum and gas tubes, such as thyratrons of the three general sizes, cathode ray oscillograph tubes, some radio rectifier tubes, neon tubes,

[3] Donald Turner, *Trans. Faraday Soc.*, **27**, 112–24 (1931).

lightning arrester tubes, and quite a number of miscellaneous and experimental tubes. These applications call for insulators which are either in contact with hot (tungsten) filaments or close to such hot filaments. Such insulators should not react with the filaments at the maximum temperatures reached either in the "bake-out" or in operation; and they should have fairly good insulating qualities at these temperatures.

In all of these many applications only pure oxide insulators have been used, the oxide selected for a particular tube depending upon the temperature of the filament, the proximity of the insulator to the filament, and upon

TABLE VI

PROPERTIES OF REFRACTORY OXIDES

Fused oxide	Melting point	Specific gravity	Heat capacity (cal./g. 50°C)[f]	Linear coefficient of expansion[g] (25–800°C)
ThO_2	3050°C[a]	9.3–9.7	0.059	9.3×10^{-6}
MgO	2800[c]	3.6–3.7	0.232	13.4×10^{-6}
ZrO_2	2687[b]	5.7–6.1	0.106	6.6×10^{-6}
BeO	2570[d]	3.0	0.261	(7.5×10^{-6})[h]
Al_2O_3	2050[e]	3.9–4.0	0.198	7.9×10^{-6}
SiO_2 (vitreous)	1713[e]	2.2	0.185	0.5×10^{-6}

[a] ThO_2 3050 ± 25°C: Ruff, Ebert, and Woitinek, *Z. anorg. allgem. Chem.*, **180**, 252–56 (1929).

[b] ZrO_2 2687 ± 20°C: F. Henning, *Naturwissenschaften*, **13**, 661 (1925).

[c] Kanolt, *Jour. Wash. Acad. Sci.*, **3**, 315 (1913).

[d] BeO: 2570°C is given by Wartenberg and Werth, *Z. anorg. allgem. Chem.*, **190**, 178–84 (1930); Ruff, *ibid.*, **82**, 373–400 (1913) found a value of 2525°C which Wartenberg corrects to 2585°C, based on the new constants for the optical pyrometer. In spite of these determinations most of the literature still quotes an old value of 2400°C.

[e] Greig, *Amer. Jour. Sci.*, **13**, 7 (1927); for cristobalite.

[f] Recalculated from International Critical Tables, Vol. 5, pp. 95–101 (1929).

[g] (1) George E. Merritt, *Trans. Amer. Electrochem. Soc.*, **50**, 165–75 (1926).

(2) More recently J. B. Austin (*Jour. Amer. Ceram. Soc.*, **14** [11], 795–810 (1931)) has measured the thermal expansion of oxides. The following values are calculated from his volume coefficients. For the range 20 to 800°C, linear coefficients of thermal expansion are MgO 13.45×10^{-6}, Al_2O_3 aggregate 5.93×10^{-6}, Al_2O_3 (sapphire) 8.33×10^{-6}, ZrO_2 7.63×10^{-6}.

[h] BeO: A communication from the Bureau of Standards (G. E. Merritt) gives an average thermal coefficient of 7.5×10^{-6} for sintered BeO between 25°C and 425°C. This is a preliminary finding.

several other minor factors. Of the several oxides listed in Table VI, Al_2O_3 and BeO are the most stable in contact with a hot filament and except for differences in melting point, they behave very much alike. They are stable up to their melting points, showing no signs of vaporization or reduction. Al_2O_3 and BeO remain white under these conditions. MgO shows signs of vaporization as low as 1800°C and the insulator recedes from the hot filament. Under conditions of very close contact there is reaction between MgO and a hot tungsten-filament leading to reduction of the MgO and a deposit of metal on the cooler parts of the tube, usually as a dark deposit on the glass of the bulb. Such reaction affects the filament causing it to become brittle and diminish in diameter. ZrO_2 has been experimented with a great many times without satisfactory results. Under

the conditions of manufacture and firing in a hydrogen atmosphere in contact with molybdenum, ZrO_2 insulators have always turned quite dark and shown signs of reduction. It is not known whether the reduction is due to the zirconia itself or to impurities in the zirconia although many attempts have been made to differentiate between them. A number of chemically pure lots has been worked with and, as signs of reduction were found with each, no ZrO_2 insulators have been used in tubes. ThO_2 has the distinction among oxides of having the highest melting point, a decided advantage, and of having the greatest density, a disadvantage. ThO_2 is somewhat reduced by a very hot tungsten filament, indicated by a darkening of the insulator, darkening of the bulb, and corrosion of the insulator and filament.

In deciding upon which insulator material to use for a particular tube application, it is essential to learn not only the maximum operating temperature of the filament during life, but the "flashing temperature" during the "bake-out" and "exhaust" of the tube. Invariably the "flashing temperature" is higher than the operating temperature by several hundred degrees, and the insulator must withstand the "flashing temperature" successfully. The argument that "flashing" a filament at a temperature above the melting point of the insulator for only a few seconds does no harm has not proved correct.

Comparative tests have been performed from time to time on insulator assemblies. Just two will be mentioned here. With a type (*b*) filament, but of much smaller dimensions, namely, 12 mils diameter, Al_2O_3, MgO, and ThO_2 tubes were compared. MgO was condemned for the particular application because of the grooves cut into the insulator by the hot filament, and because of the reduction of MgO to Mg which deposited itself on the glass wall of the tube. The Al_2O_3 and ThO_2 were stable under these conditions. Other experiments have shown also that in general MgO reacts more readily with hot metals than do Al_2O_3, BeO, or ThO_2.

Quantitative determinations were made of the conductivity of the oxide insulator tubes when heated by a tungsten coil wound around them. The current flow between the hot coil on the outside and a wire on the inside of the tubes was measured when the coil was running at 2125°C (2400°K). The order of decreasing conduction of the oxides was (1) ZrO_2, (2) ThO_2 (in milliamperes), (3) MgO, (4) Al_2O_3, and (5) BeO (in microamperes). In one duplicate set ThO_2 showed a leakage of 40 milliamperes and BeO only 0.5 microampere when 16 volts were applied across the insulator, whose thickness was about 45 mils. Under such conditions of operation ZrO_2 and ThO_2 became quite dark and there developed reaction products on the glass walls. MgO remained white and became badly etched, Al_2O_3 remained white and slightly etched, and BeO remained white and unaffected. It should be noted that the Al_2O_3 insulator was at the

disadvantage of having supported a filament which ran hotter than its own melting point, 2050°C. Filaments on ThO_2 insulators lasted 43 to 49 hours whereas filaments on BeO were going strong at 60 hours, with no signs of attack.[4]

Although ThO_2 and ZrO_2 have smaller heat capacities than Al_2O_3, BeO, and MgO, little advantage can be taken of these differences. Usually the space allotted to an insulator is set at a minimum to a given volume of insulator. Due to the greater densities of ThO_2 and ZrO_2, the heat capacities of the oxides in terms of calories per cubic centimeter (multiplying calories per gram by density) are not so widely apart. Only slight attention has been paid to the relative thermal conductivities of these oxides due to the greater importance of other properties.

TABLE VII

RELATIONSHIP BETWEEN ELECTRICAL RESISTANCE AND TEMPERATURE (WERNER)

	SiO_2	Al_2O_3	MgO	CaO	Fired kaolin
True sp. gr.	2.24	3.82	3.32	3.35	2.61
Pore volume (%)	25.42	25.78	24.75	25.25	17.46
Specific electric resistance (ohms per cc.)					
1000°C	89,500	730,000	420,000	390,000	20,500
1100	62,000	310,000	104,000	154,000	13,200
1200	38,000	105,000	35,000	39,000	5,400
1300	24,500	52,000	12,300	14,000	3,200
1400	17,500	20,000	6,300	5,800	1,800
1500	14,200	9,200	3,200	2,300	1,100
1600	10,800	4,700	1,400	1,200	890

(4) Relationship between Electrical Conductance (or Resistance), Temperature, and Porosity of Pure Oxides

(1) Spanner[5] in his work on electron emission of heated oxides made some conductivity measurements on BeO, MgO, CaO, SrO, and BaO between temperatures of 600°C and 1000°C. At any given temperature the specific electric conductances of the oxides were in the order given, BeO having the least and BaO the most conductance. On plotting the logarithm of the specific conductance against the reciprocal of absolute temperature, a straight-line relationship is obtained for each oxide, the conductance increasing with increase in temperature.

(2) Werner[6] in his recent thorough study has found similar straight-line relationships between the logarithm of specific electrical resistances and the reciprocal of absolute temperature. He used pure oxides in a number of cases and worked in the temperature range 600 to 1600°C. The speci-

[4] These experiments were kindly carried out by Mary Andrews of this laboratory.

[5] H. J. Spanner, *Ann. Phys.*, **75**, 609–33 (1924).

[6] Karl Werner, "Electrical Resistance of Refractory Materials at High Temperatures," *Sprechsaal*, **63** [29], 537–39; [30], 557–59; [31], 581–83; [32], 599–601; [33], 619–23 (1930).

mens were pressed into disks 15 millimeters diameter and 5 millimeters high, and fired. Exact measurements were made of water absorption, and the equivalent per cent pore volume was calculated. Electrical resistances were measured between graphite supports. From his data Table VII has been assembled to show the relationship between electrical resistance and temperature, 1000 to 1600°C, maintaining a pore volume of about 25% for the four oxides. Al_2O_3 appears to be a better insulator at the high temperatures than MgO, CaO, or fired kaolin. The moderate decrease in resistance with rise in temperature for SiO_2 is rather surprising. From Werner's data, Table VIII has been compiled to show the effect of

TABLE VIII

RELATIONSHIP BETWEEN POROSITY OF SPECIMEN AND ELECTRICAL RESISTANCE (WERNER)

	Specific Electrical Resistance in Ohms per cc. at 1600°C				
Pore* volume (%)	SiO_2	Al_2O_3	MgO	CaO	Fired kaolin
31–32				1400	
28–29		5200	1500		
25–26	10800	4700		1200	
24–25			1400		
23–24	9100			1200	
21–22				960	
20–21	8500	4100			
19–20	7100				
18–19		4000			
17–18			1300		890
15–16					800
14–15			1100		790
13–14					760

* Werner gives exact pore volume data calculated from water-absorption measurements.

porosity on the electrical resistance of these materials. Only one temperature, 1600°C, has been selected. There were no exceptions to the rule that the specific electrical resistance increased with increase in per cent pore volume. It should be noted that the extruded insulators described in this paper had much higher porosities than Werner's disks.

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THE BUCKLING OF WALL TILE*

By Hewitt Wilson

ABSTRACT

A description is given of the separation of wall tile from their cement backing in a Seattle apartment hotel. Tests of the tile and delayed observations indicated that the failures were caused by an excessive shrinkage of the cement-clay-sand backing wall. Precautions should be taken against setting tile on a green unshrunk, flimsy, backing wall, especially when the plastered surface is over 1 inch in thickness and can shrink *en bloc* over large areas. An excessive amount of clay or other plasticizers will likewise increase the shrinkage and danger of separation.

I. Introduction

The tiled walls of fifty bathrooms in a large apartment hotel in Seattle separated from their cement backing and had to be replaced by the tile contractor.

The 6- by 3-inch white wall tile from "A" company had been placed on the back and end walls, rising from the top edge of the bathtubs for 19 rows. Each end wall was 55 by 30 inches with a back wall of 55 by 57 inches.

The tile were set in the spring and early summer of 1928 and started to come off in the fall and winter of the same year. Failures were found on both the end and back walls. In most cases, the tile on the back wall showed a distinct bulge in the center and a complete separation from the cement backing. Loosening was indicated by a hollow sound when tapped and in severe cases the tile fell into the tub when the hot water was turned on. The end walls with one free side showed an apparent expansion, indicated by rupture of the paint and plaster on the adjacent plastered walls and a little collection of plaster dust particles at the foot of the wall, suggesting differential movement of tile and backing wall.

As in many cases of construction failures, numerous conflicting data were presented. No such wholesale case of separation was known among the tile setters of Seattle nor to several eastern tile men. The tile contractor blamed the tile and others blamed the tile contractor for "rushing the job."

II. Previous Examples and Tests

J. W. Mellor[1] made observations and tests on similar occurrences. F. K. Pence[2] also observed crazing when the tile was set in cement, and N. D. Wood[3] reported observations on buckling of wall tile.

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[1] J. W. Mellor, "The Setting of Cement and the Buckling of Floor Tiles," *Trans. Ceram. Soc.* [Eng.], **6,** 123 (1907); "A Comparison of the Thermal Expansion of Floor Tile and Cement," *ibid.*, **5,** 159 (1906).

[2] F. K. Pence, "Crazing Test for Wall Tiles," *Trans. Amer. Ceram. Soc.*, **18,** 622–30 (1916).

[3] N. D. Wood, "Research into the Buckling of Floor Tiles," *Trans. Ceram. Soc.* [Eng.], **29,** [2], 63–83 (1930).

III. Observations of the Seattle Failure

(1) Concrete Wall Shrinkage The "M" apartment hotel is a reinforced concrete building of eight floors with 123 one-, two-, and three-room apartments. Since the concrete was poured in the early spring, it was never thoroughly dry until the following fall and winter when artificial heat was used for the first time for any duration.

That reinforced concrete shrinks and cracks is known. Floor panels, 17 by 17 feet, will crack through 7-inch thickness during their first drying-out period. Certain bath rooms of the "M" apartment could have been caught in the squeeze of certain walls and the rigid tile bulged away from the cement. Such a general movement of the walls was not indicated, however, by cracks. The walls surfaced with other materials did not indicate that they were compressed.

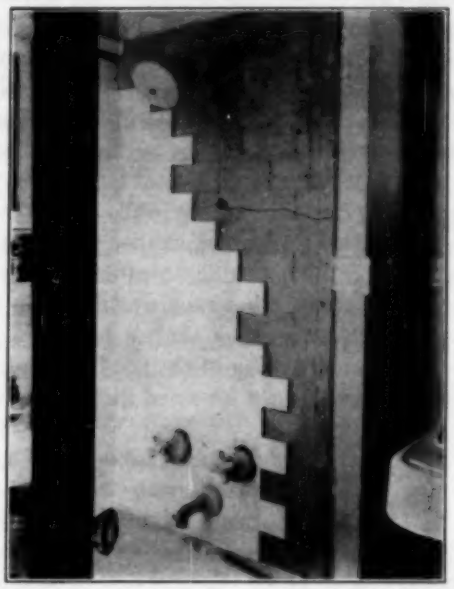

FIG. 1.

(2) Type of Wall The wall is the type known as a plastered metal lath, tied to $^3/_4$-inch vertical channel irons spaced about 24 inches. The following scratch coat put onto both sides of the metal lath consisted of 4 sacks Keene cement, 8 cubic feet lime putty, 1 cubic yard extra coarse sand, and 12 pounds manila fiber.

This was followed as usual on the side away from the tile by the application of a brown coat and then a finish coat, but the last two were omitted from the tile side in those areas to be covered by the tile.

The tile setters followed with a 1 : 3 cement-sand scratch coat within one to three days after the plastering. This scratch coat contained 27% by weight plastic fire clay for plasticity ($^3/_4$ buckets of clay to 1 sack cement). Since the second scratch coat was about $^3/_4$ inch thick, the $^3/_4$-inch channel irons were then buried about $^1/_2$ inch. The total thickness of the two scratch coats on the tile side of the metal lath was $1^1/_4$ inches.

In most cases the tile were set the following day. The scratch coat was dampened, a neat cement float coat was applied, and the soaked tile

pressed into the cement and smoothed into a plane surface with a straight edge. Neat white cement was flushed into the joints and the excess wiped off. The walls were not supposed to be "buttered" with the float coat in areas too large or the cement would get an initial set before the tile were applied. That the tile were pressed or well hammered into place was shown by the deep and nearly perfect impressions of the back of the tile in the float cement coat. (See Fig. 1.)

The tile were usually soaked in water for 10 to 15 minutes or at least until the air bubbles stopped. As usual, no attempt was made to keep the walls damp after the tile were applied.

(3) Condition of the Walls Most of the walls showed a bulge in the center on the tile side when tested with a straight edge. The opposite side of the wall sometimes showed a concave surface and sometimes did not; some even showed another bulge in the opposite direction. In general, the metal-lath walls, whether tiled or not, showed more irregularities than those walls made by plastering over hollow clay tile or concrete. In other words, the metal-lath walls had moved in an irregular fashion during or after the application of the plaster. In most rooms a wooden hat rack was nailed in the clothes closet on the back side of the tiled wall after the tile had been placed It is not known whether the cement backing of the tile had hardened or not. The hammering was at least bad for the loosened tile. Most end walls were finished only on one side.

(4) Separation of the Tile In most cases all of the tile from top to bottom were lifted from the wall. A blue 1- by 6-inch border tile near the top of the panel, made by another manufacturer, showed the same ease of removal as the 3- by 6-white tile, although some of the tile setters who made the repairs, stated that the blue tile clung to the cement better and had to be cleaned before replacement. The imprint of each tile was clearly seen in the cement float coat which had been left in tight adhesion to the scratch coat beneath.

(5) Cracking of the Cement Backing After the tile had been removed, vertical cracks were noted over each channel iron. These continued the full height of the tile panel and ended in fine cracks a few inches above the top row of tile. They had undoubtedly formed shortly after setting, for the painters had in most cases covered them with a film of wall paint. The vertical cracks back of the tile were large cracks from $^1/_{16}$ to $^1/_8$ inch wide. Horizontal cracks likewise were noted, crossing the vertical cracks from 20 to 24 inches apart but in a more irregular fashion. These cracks showed that the cement backing had shrunk between the vertical channel irons in approximately square areas of about 24 by 24 inches. The shrinkage of the cement background was

very apparent, and was far greater than the shrinkage of the adjoining plastered walls.

(6) Tile over Heated Walls In a few cases tile had been set with insufficient protection against heating stacks. These areas showed poor cohesion, but in these cases the adjacent plastered and painted areas likewise showed cracking. The trouble here was not confined to the tiled areas.

(7) Durability after Replacement In not one of the 50 cases replaced did a second failure occur. The conditions were undoubtedly more conducive for more rapid drying in the replacement than during the initial setting. The building was occupied and heated, and the walls were dried. The setting in this case, however, was made on a hardened wall which had obtained its full shrinkage. Apparently the shrinkage of the float or butter coat of neat cement was of no serious consequence.

(8) Coefficient of Expansion Tests Expansion tests were made on ten "A" tile which had separated from the cement in the "M" apartment, ten "A" tile which had never been used, and ten tile from "B" manufacturer which had never been known to give this trouble. The expansion was made between 14°C and 89°C, a difference of 75°C or between 57.2°F and 192.2°F, a difference of 135°F.

COEFFICIENT OF EXPANSION

	Coeff./°C	Coeff./°F	Expansion in 135°F for 9½ tile (57 in.)
"A" tile (new)	8.63×10^{-6}	4.79×10^{-6}	0.037 in.
"A" tile (used)	5.92×10^{-6}	3.29×10^{-6}	0.0257 in.
"B" tile (new)	10.03×10^{-6}	5.57×10^{-6}	0.0428 in.

The expansion found for the used tile was actually lower than a second batch of the "A" tile and both batches of "A" tile gave lower expansions than the well-known "B" tile.

The difference between the expansion of neat cement and the used "A" tile (which was the worst case) for 9½ tile (the length of the bathroom wall) was 0.0055 inch when 9.2 by 10^{-6} was used as the coefficient of neat cement.[4] This difference in thermal expansion between the cement and tile is negligible in comparison with the differences in size caused by the shrinkage of the scratch coats during drying.

The difference between the thermal linear change of neat cement and fired tile over 135°F or 75°C was approximately 0.00116 inch per foot. The differences in length between the scratch coat and the tile after the former had shrunk and cracked during drying varied between 0.031 and 0.063 inch per foot or over 30 times as much as that caused by differential thermal changes.

[4] See footnote 1, p. 252.

The relative rates of heating caused a greater stress. If the entire thickness of the wall had a temperature of 14°C, and a temperature of 89°C or more had been applied suddenly to the tile surface, the tile would expand before the cement backing and the differential but temporary expansion would then be of the order of 0.007 inch per foot or between 0.0257 and 0.037 inch per $9^1/_2$ tile (the length of the wall). This stress would have been dissipated as the heat penetrated the wall and is small when compared to the shrinkage of the cement upon drying.

(9) Cohesion Tests with Cement Eleven tests were made of the sticking properties of the "A" and "B" tile in pairs with three brands of Portland cement: (1) gray "superior" Portland cement used on the job, (2) white "'Medusa" cement, and (3) white Atlas cement.

Method: The cement was mixed with water in the usual manner and buttered on an "A" and "B" tile which had been thoroughly soaked in water. The two tile were then pressed together, back to back, and the excess cement removed from the sides. The different pairs of tile were kept in a damp closet for 24 hours and then soaked in water for various lengths of time to a maximum of 28 days. Attempts were made to split the tile apart after varying lengths of time and varying treatments.

Cohesion was always good while the cement was damp, if the tile had been together long enough for the cement to harden. But all could be separated *cleanly* from all the cements if they were thoroughly dried either by just standing in the warm room or more quickly when placed on a hot steam radiator. In all cases the split was even and clean for the gray Portland cement. The Atlas cement showed some cohesion to the tile but this did not prevent an easy separation. Fine hairlike cracks were noted in the cement backing of each pair. This separation was due to the shrinkage of the Portland cement as it loses its excess water and similar shrinkage cracks can be seen in most concrete roadways, walls, and floors. It is not due to differences in thermal contraction but to the shrinkage of the cement as it dries.

The above series of tests made on 11 different pairs of tile indicated that the "A" tile were not inferior to the "B" tile in their holding properties to neat Portland cement.

(10) Absorption Tests The per cent absorption was determined by boiling 10 samples of each brand in water for five hours and noting the increase in weight.

	Absorption of Tile (%)	
	"A" Tile	"B" Tile
Maximum	15.3	14.2
Minimum	11.8	10.8
Average	13.5	13.0

The "A" tile showed a greater absorption than the "B" tile but the difference was not large enough to prove or disprove the holding ability of either. A rough test of the size of the surface pores was made by drawing a pen across the back of the tile so that the ink came in contact with the unglazed surface. The "A" tile in most cases showed a wider or heavier ink line, indicating that the surface pores are larger in the "A" tile than in the "B." Larger surface pores would probably give a better grip to the cement. The "A" tile have been used on several other Seattle jobs by different contractors without failure.

(11) Miscellaneous Observations

(*a*) This was the first time that this contractor had used the "A" tile.

(*b*) It was likewise the first time that this contractor had set tile on the thin metal-lath partition.

(*c*) Is there any harm in placing a 1:3 sand:cement coating over a gypsum-lime-sand scratch coat? Do the two work together?

(*d*) The rooms in which the failures occurred were scattered in an irregular fashion over the whole building.

(*e*) Far greater shrinkage occurred in the cement backing behind the tile than in the plastered walls above the tile or on the opposite side of the wall. Deep cracks behind the tile only extended a short distance into the painted walls above.

IV. Possible Causes of Failure

(1) Rushing the Job

Several other tile setters, when asked about the possible causes of failure, thought that it might be due to a "rushed job." They complained of the "California system" in which a large area is buttered with neat cement and the tile stuck on and hammered into place. This is a faster system than the older one which consists of buttering each tile separately with cement. If the neat cement coat or float coat had received its initial set before the tile were pressed into position, it is possible that poor adhesion would result. In good practice the tile setter should not allow the buttered wall to stand over 15 minutes before it is covered with tile. This means about two rooms per day or 16 square feet for one setter and his helper.

If the failures had occurred with only a few green men, such would possibly have been the case. But the tile laid by some of the oldest and most careful workmen in Seattle came off as easily as tile laid by the least experienced men.

It is easy to note when the cement has reached its initial set for the tile refuse to stick. If the failures were due to delayed setting, the tile next to the tub or those which were set first would show good adhesion while the top tile would not. The failures, however, were distributed over the whole wall.

(2) Too Much Water in the Cement Another suggestion was made that too much water had been used in the cement and water was seen to be oozing out between the tile the next day. It has been proved by many cement experiments that an excess of water decreases the strength of the cement. A film of water on the wet tile might prevent adhesion, at least temporarily. The cement for this job was mixed for all the tile setters by one man and he thus could have caused a universal failure by producing poor mortar. An experienced tile setter, however, would soon complain if the float cement coat were too wet. The tile would slide as he tried to hammer them in place. He would not be able to smooth the wall, which would cause him to lose time. Some water markings or open spots where bubbles of water collected by setting the tile in position were noted but not in sufficient quantity to destroy the whole bonding power. They have been noted in other places where adhesion was good. A scratch coat only 24 hours old still contains a large quantity of water. The combination of soaked tile, plastic float coat, and wet scratch coat would retard the usual suction and quickly appearing firmness. Water would probably be noticed on such a wet wall for hours after the setting and wetness would be noticed around the joints. This could not have been very bad or the wall would have lost its shape and the tile would have slumped. Dampness is conducive to better strength of cement in comparison with rapid drying during the setting period.

The job was undoubtedly rushed, not from the standpoint of actually placing the tile into position, but by setting the tile before the foundation coats were completely dried out and had acquired their permanent volume.

(3) Insufficient Soaking of the Tile before Setting If the tile are still capable of withdrawing moisture from the cement, the cement may be weakened. The time required to fill the bulk of the pore space, however, is small and most tile setters have been carefully instructed in the proper soaking of tile. The universal distribution of failures over the whole job, representing the work of so many experienced tile setters, eliminates this as a possible cause of the wholesale failure.

(4) Poor Cement The same batch of cement which caused the failure was tried later by the tile setter contractor and found to be of usual quality. A few sacks of poor cement could possibly have slipped into the job and have been used by a number of different tile setters in the 50 different rooms for the float coat, but it would undoubtedly have been noticed by some of them. Likewise, the cement backing exposed in the cases of failure were examined and found to be normal in strength and hardness. The causes of failure were apparently new to the tile setters.

(5) Soluble Salts in the Cement or Plaster From the experiments of N. D. Wood[5] the admixture of tannin, sugar, borax, dextrine, or glycerine, and possibly others would have destroyed the strength of the cement. But the strength of the cement was not destroyed as indicated by observation of the cement backing from which the tile separated. A decrease in strength would still have left the tile in weak adhesion to the cement. It is not likely that the bulging of the walls would have been so pronounced unless the shrinkage of the cement had been excessive.

Peeling of painted concrete surfaces has been caused by a layer of soluble salts forming on the surface under the paint when water has been permitted to penetrate the wall. No evidence of such an accumulation of salts was noted, and the separation of the tile in a given room did not follow the usual variations of soluble salt accumulations which usually form in a most irregular fashion following the evaporation of water. Most of the water loss would likewise be through the opposite side and not the glazed tile side.

V. Conclusions: Causes of Separation

The causes of the buckling were thought to be the same as those which have been ably described by J. W. Mellor and N. D. Wood.

(1) Excessive shrinkage of the $1^1/_4$-inch layer of plaster and cement *en bloc* behind the tile, during or just following the growing period of the cement to the tile.

(2) (*a*) Excessive shrinkage may be caused by too rich a cement mixture, (*b*) too much water, (*c*) too much fire clay which likewise adds more water, and (*d*) it is necessary to have a theory that will show a variation of action. Some walls peeled and others did not. The variation was found in the irregular type of cracking which occurred in the cement backing. Cracking *en bloc* over large areas caused separation. Minute cracking well distributed over large areas instead of a few large cracks was apparently less conducive to cracking.

VI. Remedies

(1) Provide a well-shrunk, permanent, solid backing wall. A green wall must be dried, shrunk, and cracked before tile are applied.

(2) Reduce the shrinkage of the cement backing by (*a*) leaner mixtures of scratch and browning coats, (*b*) less water, (*c*) less fire clay, and (*d*) substitute hydrated lime for fire clay.

(3) Reduce the shrinkage of large areas *en bloc* by using (*a*) the metal lath on the tile side of the channel irons, (*b*) fiber in the plaster and tile scratch coats, and (*c*) wood or metal strips embedded in the scratch coats.

(4) The possible use of an elastic cement which will retain its flexibility

[5] See footnote 3.

until after the backing has dried and cracked. This cannot be used on wet surfaces.

VII. Probable Combination of Circumstances in the Seattle Failure

(1) The light partition walls were bent and buckled in an irregular fashion by the shrinkage movements of the concrete building walls as they dried.

(2) The metal lath was placed on the tile side in some rooms and on the opposite side in other rooms. This gave a variation in the type of cracking.

(3) In some rooms the tile setters followed the plastering too closely and the plaster scratch coat was not given sufficient time to set and shrink.

(4) The tile setters used a scratch coat with a dangerous amount of plastic clay.

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THE USE OF NATURAL GAS IN FIRING STRUCTURAL CLAY PRODUCTS[1]

By Marion W. Blair

ABSTRACT

Some of the advantages of natural-gas firing are enumerated and the thermal value and cost of natural gas are compared with coal. Other points discussed in the paper are: (1) the influence of irregular operation and length of firing schedule on economy, (2) the value of controlled air supply under pressure, and (3) the reported gas consumption for various products in different districts.

I. Introduction

The heating value of natural gas is measured in heat units per cubic foot at a given pressure and the consumption is metered by direct reading or by calculating from pressure differences on either side of a known size orifice. Bills are rendered in most localities on 1000 B.t.u. per cubic foot at 8-ounce pressure. On this basis it requires 24,000 cubic feet of gas to equal in heating value one ton of 12,000 B.t.u. per pound coal. Therefore, gas at twenty cents per thousand cubic feet is equivalent in heating value to $4.80 of coal delivered at the kiln.

To be economical, every advantage which gas possesses must be utilized. The labor saving on a 40,000 brick per day, ten-kiln plant would amount to 30 cents per thousand brick, or about 60 cents per ton coal equivalent, bringing comparative gas cost down to $4.20 per ton.

The amount of unburned fuel in the ash averages 2% of the coal, which should be credited to the cost of the gas.

II. Advantages of Gas

Compared with coal, gas is a quick-burning fuel. It ignites instantly, producing high local or fire-box temperatures. There is no slow coking of the fuel, no maximum or peak temperatures, and no subsequent recession as there is each time the firing of coal takes place. There are no unburned solids carried over into the ware at low temperatures and deposited in the form of soot or ash, with a consequent draft choke and collection of moisture. For this reason the water-smoking period can be carried through in much less time.

Note: The ordinary cold-rod test, however, for clearing water smoke must be taken with exercise of judgment, or a slowing up and consequent loss of fuel will result. Natural gas in many localities has a high hydrogen content, resulting in considerable water vapor in the flue gases so that the cold-rod test will show water long after the water-smoking period is past.

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Structural Clay Products Division). Received January 5, 1932.

III. Essentials to Economic Advantages of Gas

It is important to reduce the firing schedule to a minimum or, in other words, to determine the maximum safe shrinkage rate, to reach that rate as quickly as possible, and to maintain it. It is a greater waste with gas than with coal to settle a kiln one-fourth inch per hour if the material will stand a rate of one-half inch.

It is more economical to run the gas consumption at 9000 feet per hour and to obtain a three-eighths inch settle per hour or nine inches in 24 hours, than to fire 8000 feet per hour over a period of 36 hours to obtain the same settle, the gas consumption in one case being 216,000 cubic feet, and in the other, 288,000 cubic feet.

IV. Plant Results Obtained

Accurate figures as to cost per ton of ware have been available on only a few plants. The figures for the total gas consumed are in most cases arbitrarily distributed to power, drying, and firing.

In Texas, the average consumption for these three operations was 6000 feet per ton of ware. The rate is 19 cents for the first 1,000,000 cubic feet, 18 cents for the next 9,000,000, and 17 cents for the excess over 10,000,000, with a rebate based on the current price of fuel oil which has amounted to from 1 to $2^1/_2$ cents per 1000 feet. Under these conditions a 40,000 brick plant would pay a total fuel cost of 90 or 95 cents per ton of ware.

On one plant firing hollow tile in an open-top continuous kiln at a temperature of 1850°F, the gas consumption for firing alone has run as low as 2500 cubic feet per ton, a very low figure.

The highest gas consumption reported was at Cannelton, Indiana (12,000 cubic feet per ton), the ware being salt-glazed 4-inch sewer pipe, a long firing schedule and a low tonnage in the kiln evidently being responsible.

In the St. Louis district, on salt-glazed sewer pipe, a consumption of 8000 feet per ton of ware has been reported by several plants. The 8000 cubic feet of gas would have a thermal equivalent of 666 pounds of coal, which is 17% less than the best coal consumption in the Cannelton experiment.

At another plant in the St. Louis district, firing a variety of brick (builders, dobies, and paving brick) there has been a gradual improvement over a period of more than a year of continuous operation. The improvement has come about with the introduction of the pressure type of burner and the consequent cutting of the firing time. Comparative figures available on the same kiln and the same type of product show in one case a schedule of 151 hours and a consumption of 4532 feet per ton against a schedule of 99 hours and a consumption of 3087 cubic feet, a difference in time of 34.4% and in gas consumed, 31.8%.

At a plant in southern Indiana, firing face brick and building and drain

tile of surface clay at temperatures ranging from 1850 to 1900°, a consumption of 5700 cubic feet per ton of drain tile in intermittent firing has been obtained.

V. Conclusion

It is evident that the minimum is not yet known on any plant. The old habit of assuming that a particular material is not subject to any change in method of handling, even when the facts of that method are not known, will delay the economical use of natural gas in the ceramic industry. In order to get the utmost in economy, cutting the firing time must be recognized as a possibility; a complete record over a number of firings must be kept, and a schedule must be worked out intelligently for each plant, using every advantage which such a fuel offers.

The figures given, while of a general nature, are from actual plant operations and are taken from plant records.

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CERAMIC ABSTRACTS[1]

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Vol. 11 April, 1932 No. 4

Abrasives

Hydraulically operated universal grinding machine. Landis Tool Co. *Abrasive Ind.*, **13** [2], 28–29 (1932).—An outstanding feature of the new 10- x 24-in. hydraulic universal grinder is the hydraulic table traversal which gives a range of table speeds from 6 to 144 in. per min. with smoothness and ease of control. E.P.R.

Cam grinding machine. Anon. *Mech. World*, **90** [2346], 592 (1931).—In a machine designed for grinding cams a template reproduces the form desired, the work and template being fixed on the same arbor, the work at the front end of the headstock spindle, and the template at the other end. E.P.R.

Centerless grinding. E. Mernagh. *Mech. World*, **90** [2344], 545–46 (1931).—The centerless grinding machine is being increasingly employed on such parts as gudgeon pins, dowel pins, drills, and shafting, producing accurate cylindrical or tapered work without the necessity of mounting the work between centers. The control wheel, the abrasive wheel, and the guide plate form the main parts of the machine. Material from $^1/_{16}$ to 3 in. diameter can be dealt with. The usual size of grinding wheel is 18 in. diameter and the control wheel, 9 in. diameter. E.P.R.

Lap shaft bearings and pins. Norton Co. *Abrasive Ind.*, **13** [2], 29–30 (1932).—A new crankshaft lapping machine has been developed for lapping simultaneously the pins and bearings of automotive crankshafts. The shaft to be lapped is rotated between a live headstock and a floating footstock center. The lapping arms, one of which is required for each pin and bearing, are equipped with telescoping reels, each carrying a roll of abrasive paper. When a lapping arm is removed from a pin or bearing these reels are indexed automatically, thus presenting a fresh, unused abrasive surface to each pin and bearing lapped. E.P.R.

Device for feeding polishing compound. Hammond Machinery Builders. *Brass World*, **28** [1], 17 (1932).—A device for automatically feeding polishing compound to automatic, semi-automatic, or hand-polishing machines has been developed. E.P.R.

Diamond cutting tools. K. Lockwood. *Mech. World*, **90** [2346], 591 (1931).—Details of cutting angles and speeds and methods of fixing in the holders are described. E.P.R.

Machine for testing strength of grinding wheels. Abrasive Engineering Corp. *Metal Cleaning & Finishing*, **4** [1], 45 (1932).—The Grade-O-Meter accurately measures the strength of resistance of the bond of grinding wheels and indicates in definite units,

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

expressed in plain figures, the true grade of the various grinding wheels and also the variation in grade at different points on the same wheel. Illustrated. E.J.V.

Wheel speed governs production. ANON. *Abrasive Ind.*, **13** [2], 25–26 (1932).—The faster a wheel is operated the more cutting points per minute will be presented to the work. Since centrifugal force increases with the square of the velocity, a wheel at a peripheral travel of 6000 ft./min. is subjected to four times the strain of one running at a surface speed of 3000 ft./min. A wheel operated satisfactorily at 6000 ft./min. begins to act soft as it wears away. Correct operating speed on an electrically driven machine is maintained by adjustment of the work rest as the wheel wears. This automatically increases the speed. In increments of 1 in. diameter, the peripheral travel would be reduced as follows, if no provision were made for increasing the wheel speed.

Diameter (in.)	Surface speed (ft./min.)	Diameter (in.)	Surface speed (ft./min.)
30	6000	27	5400
29	5800	25	5001
28	5600	24	4800

At least five speed changes are necessary to keep the wheel approximately at its original peripheral travel. E.P.R.

Curved profiles require special grinding methods. ANON. *Abrasive Ind.*, **13** [2], 20 (1932).—For accurate grinding or complex curved or angular surfaces it is necessary either that the wheel or the work be moved in such a path as to generate the required surface, or that the wheel be formed to cut its special shape into the work. The latter is known as form grinding. For form grinding, standard cylindrical or surface grinding machines may be used as contrasted to generating methods which require special machines. Few grinding machines have power enough to drive a formed grinding wheel greater than 10 in. in width. Grinding wheels of greater width are expensive and difficult to handle. The heat generated increases as the width of the cutting contact increases. These factors combine to limit the width of the surface cut with one wheel. In the generating method, a simple surface moved in the path required will generate a more complex surface. A straight grinding wheel can be caused to cut a concave or convex surface of revolution simply by swinging the axis of the grinding wheel about a point which is to be the radius of the surface to be cut if the periphery of the wheel is straight and has appreciable width. E.P.R.

Modern polishing methods in cleaning ornamental castings. JOHN HARSCH BRONZE & FOUNDRY CO. *Abrasive Ind.*, **13** [2], 32–33 (1932).—Modern ornamental cast metal is superior to that formerly made. This article illustrates and describes briefly some abrasive operations followed in cleaning and finishing aluminum and monel metal castings. E.P.R.

Speed of grinding machines. ANON. *Mech. World*, **91** [2349], 40 (1932).—Both vitrified and silicate wheels for general purpose grinding are considered suitable for peripheral speeds up to 5500 ft./min., or diameter of wheel in inches times r.p.m. = 21,000. For precision grinding slightly higher speeds are usual, *e.g.*, 6000 ft./min. Elastic and rubber-bonded wheels may be run at 10,000 to 12,500 ft./min. In no case should the peripheral speed exceed 14,000 ft./min. Small wheels for internal grinding work at high speeds. Motor speeds of 300 r.p.m. are not uncommon. Correct cutting speed is most important in grinding, and as wheel diameter decreases it is necessary to increase the spindle speed. E.P.R.

Accurate production grinding in piston manufacture. ANON. *Abrasive Ind.*, **13** [2], 11–14 (1932). E.P.R.

BOOK

Development of Grinding. (Entwicklung der Schleiftechnik.) ALF SCHROEDER. Reviewed in *Abrasive Ind.*, **13** [1], 16 (1932).—This history of the development of grinding and abrasive methods is a valuable contribution to the literature of the industry. S., in the first part of the book, traces the development of abrasive technique from prehistoric times in Europe, Africa, and Asia, through the periods of classical antiquity and the middle ages up to the present time. Work in stone, metal, glass, wood, and bone is discussed. A particularly interesting feature of the book is the presentation of the work of Leonardo da Vinci which is outlined with reproductions of sketches made by the early scientist. E.P.R.

PATENTS

Roller-bearing grinder. CHARLES EDWIN RIFE. U. S. 1,841,631, Jan. 19, 1932.

Grinding machine. ROGER N. HEALD, EDWARD M. TAYLOR, RALPH A. QUIMBY, AND CARLE J. HIGHBERG. U. S. 1,841,809, Jan. 19, 1932.

Machine for grinding the teeth of gear wheels, etc. JOHN WILDSMITH SNARRY. U. S. 1,841,852, Jan. 19, 1932.

Grinding machinery. SOL EINSTEIN. U. S. 1,842,375, Jan. 26, 1932.

Apparatus for grinding gears. FRANK BURGESS. U. S. 1,842,538, Jan. 26, 1932.

Apparatus for grinding threaded work. JOHN BATH. U. S. 1,842,650, Jan. 26, 1932.

Grinding machine. STANLEY W. BATH AND HARVEY M. ALLISON. U. S. 1,842,651, Jan. 26, 1932.

Grinding machinery. CLEMENT BOOTH. U. S. 1,843,079, Jan. 26, 1932.

Machines for precision grinding. W. W. TRIGGS. Brit. 363,695, Jan. 6, 1932.

Centerless grinding machines. A. E. WHITE. Brit. 363,650, Jan. 6, 1932.

Machine tool arrangements, *e.g.*, centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 363,912, Jan. 6, 1932.

Centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 364,312, Jan. 13, 1932.

Art and Archaeology

Red uranium glazes and reduction. ARNULF HOHL. *Keramos*, **10** [25–26], 669–70 (1931).—The composition of the batch and the firing temperature are the most important factors in obtaining red uranium glazes resistant to reducing fire. Glazes having a low fusing point are more sensitive to reduction. Zinc oxide and potash feldspar used as substitute materials for lead compounds produce a harder glaze whose fusing point may be regulated. The red coloring develops immediately when the glaze begins to sinter. This is true of easily fusible glazes and especially with ware having thin bodies. Glazes having a fusing point over 1020° behave otherwise, the red color begins to develop only during the full firing. The reductions produce brown to black stripes in easily fusible glazes and spots in difficultly fusible glazes. Muffle kilns with half-gas firing are best suited for the firing of red uranium glazes, and the process of firing in them is explained. The process of firing in tunnel kilns is also described. M.V.K.

Technique in modern mosaics. EUGENE CLUTE. *Arch. Forum* [Part I], **56** [1], 69–76 (1932).—Mosaic formerly regarded as particularly applicable to churches is used for modern interior design in almost every type of building. Mosaic technique is essentially a handicraft in (1) the actual pattern design and (2) in development of that pattern into terms of subtle color relations and intricate surface treatment. Mosaics are classified as Roman, Cosmati, and Pompeiian to indicate a certain size range of tesserae and a more or less definite manner of design, setting, and finish. The method of

laying mosaics is described in elementary detail. Glass mosaic is an outstanding example of the possibilities of mosaic due to the technique developed by Louis Comfort Tiffany. E.P.R.

New decorative glassware. PAUL T. FRANKL AND MAURICE HEATON. *New York Times; Amer. Glass Rev.*, **51** [17], 26–27 (1932).—Color has been applied in individual chromatic schemes, *e.g.*, combinations of copper and yellow hues are blended in circular bands on the plates. The glaze is generally applied on the under side of the piece, thereby adding to the color of the glistening sheen of the glass. By H.'s method, which has been employed in creating decorative stained glass for church windows, it is possible to place a design of one color on a background of another as well as to merge different hues. The colors are fired in an oven after application and become an integral part of the glassware. Variations of brush work and a method of scratching decorative motifs through a surface color are part of the technique. On a dinner table the hue of the tablecloth can be seen through the slightly opaque texture of the pieces. The glass plates and bowls may be selected hues which agree decoratively with the table's chromatic scheme. E.P.R.

Solving color problems in glass, pottery, and enamel. MARY L. HULL. *Ceram. Ind.*, **18** [2], 124–26, 146–48 (1932).—H. considers the action of colors toward each other: harmony and contrast. Producers must consider the use to which their products are put and the location of the objects to determine the proper colors to be applied. A discussion of desirable colors for various articles is given. W.W.M.

High craftsmanship in making glass figurines. WALTER RENDELL STOREY. *New York Times; Amer. Glass Rev.*, **51** [19], 10 (1932).—At the Ehrich Galleries, New York, several figurines, birds, ducks, fishes, and lions, offer amusing possibilities for decoration. The French glass shows both artistic elegance and utility as suggested by small rectangular containers for flowers in heavy, thick green glass by Goupy. Vases of heavy, bubble-filled glass by Henri Navarre, whose pieces are connoisseur's prizes, suggest some primitive art. Heavy blue glass vases by Thuret and bowls of blown glass in strange hues and textures by Jean Sala illustrate the interest among foreign glassmakers in creating beautiful effects through what were once regarded as flaws or imperfections in the glass. E.P.R.

Making glass specialties in continental Europe. ANON. *Nat. Glass Budget*, **47** [37], 3 (1932).—Lanvin presents a black and white perfume flask in the watch shape. Brot advertises new three-fold dressing mirrors with rectified surfaces. Houbigant has had success with the "Etude" square flask, a pure crystal flacon with a distorting effect. E.P.R.

Artistic and technical shape of tea and coffee pots. OTTO PELKA. *Sprechsaal*, **65** [1], 1–4 (1932).—P. discusses porcelain tea and coffee pots of the 18th, 19th, and 20th Centuries. Illustrated. M.V.K.

Excavations at Susa (Persia), 1930–31. R. DE MECQUENEM. *Antiquity*, **5**, 330–43 (1931).—Unpainted pottery of Susa II was found. It was represented by vases with a spout and craters with four protuberances having lateral holes for suspension. The vases have a red slip and are decorated with designs in relief. Some have twisted handles, and others are without slip and decorated with incised geometrical designs. This level seems to belong to the beginning of the period of the Awan dynasty of Susa, which flourished about 3100 B.C. Beneath it was found another type of pottery represented by vases made of coarse but well-baked clay, vases with round bottoms and wide mouths, small jugs with long open spouts and with long pierced handles, and large and small vases with twisted handles. There were also sickles of fired clay. Below these levels were found fragments of painted pottery of Susa I, together with others of a red slipware. The latter, though remarkable for its technique, was without any decoration.

The one nearly complete painted base was a goblet of middle size decorated with the figures of three poisonous snakes. An ancient well five meters deep was protected on the inside with broad rings of earthenware. There are many vestiges of the Sassanid epoch. Vases of fired clay with and without glaze, bowls, water-flasks, and lamps were found. In tombs of the last Elamite epoch were found vases with and without glaze, sometimes good phials of molded and colored glass, and figurines of fired clay. Among the types of pottery found in the lower-level graves were high, conical, and wide-mouthed vases with bases. Similar vases were found in tombs of the 25th Century B.C., but these had flat handles on which a human bust was roughly indicated. The funerary ware of the graves of the lower level comprised large vessels of yellow clay decorated with a twisted band and with a small protuberance on the shoulder, and painted pottery. Two new designs were discovered: small vases, one of which is decorated with a serpent, the other with a line of dots between two bands. In lower levels, bowls of red clay decorated with undulated lines and small bottles painted with geometrical designs were found. In the graves, painted pottery is general. The colors, red, black, and white, are not fast and are easily washed away. The designs are generally geometrical, but figures of birds and fish occur. Brick columns and walls were often covered with plaster. Illustrated. A.J.M.

Zoölogy in pottery. FRANK DAVIS. *Illus. London News*, **179**, 870 (1931).—The treatment of animals in Chinese art is illustrated. H.H.S.

Beads from Nineveh. HORACE C. BECK. *Antiquity*, **5**, 427–37(1931).—There are several varieties of faience, most of which are in a bad state of preservation. The core is usually black, but in some cases it is a dirty white. In one case the core nearest to the glaze is white, while that nearest the perforation is black. The glazes, which are very opaque, were originally white, green, blue, red, and black. The white glaze was sometimes on a white core and sometimes on a black one. The faience beads include all the simple forms such as oblate, spherical, barrel, bicone, and cylindrical, besides triangular, square, and rectangular prisms. In addition there were imitation tooth pendants formed by inserting a piece of quartz in a piece of faience, covering with soda, and heating. Another variety of bead was the bicolor inverted drop pendant which has the upper and lower parts of different colors. These are glazed with different colors and the cores of the two parts are made of different materials. The upper part, which is perforated, is almost always black, while the lower part has a white core. This part was glazed in different colors. A third variety is the crumb bead which had fragments or grains attached to a core. Illustrated. A.J.M.

Further links between ancient Sind, Sumer, and elsewhere. ERNEST MACKAY. *Antiquity*, **5**, 459–73 (1931).—Beads and pottery of faience are discussed and described. Illustrated. A.J.M.

Dual character of the beaker invasion. J. G. D. CLARK. *Antiquity*, **5**, 415–26 (1931).—The Bronze Age pottery of Britain is divided into two groups: In AC, a high-brimmed globose beaker, the upper part which is separated from the body by a constriction and frequently very defined, spreads out like the calyx of a flower and forms a brim or neck that almost equals the body in height. The sides of the neck or rim are straight and not recurved at the lip. In B, an ovoid beaker with a recurved rim, there is no distinct demarcation between the body and the rim, but the one glides into the other by a gradual curve. The decoration of AC consists of the use on a large scale of negative and positive triangles, hexagons, chevrons, lozenges, lattices, etc. B uses mostly plain horizontal lines occasionally enclosing oblique or criss-cross hatching, with a rare use of the linear chevron and the triangle and crude stab or finger-nail ornamentation. Illustrated. A.J.M.

Roman mosaic at St. Albans. R. E. M. WHEELER. *Illus. London News*, **179**, 820 (1931); for abstract see *Ceram. Abs.*, **10** [5], 324 (1931). H.H.S.

Syrian art in 1400 B.C. F. A. C. SCHAEFFER. *Illus. London News*, **179**, 806–10 (1931).—The French Archaeological Mission to Ras Shamra and Minet-el-Beida has achieved wonderful results. Illustrated. See also *Ceram. Abs.*, **10** [5], 324 (1931). H.H.S.

Four hundred years of Mexican art. RENÉ D'HARNONCOURT. *Discovery*, **12**, 390–94 (1931).—Mexican art has preserved its individuality through four centuries of development from the crude "peasant ware." Illustrated. See also *Ceram. Abs.*, **10** [6], 405 (1931). H.H.S.

German glass painting of the 13th Century. G. BADERMANN. *Glashütte*, **61** [1], 5–7 (1931); *Glastech. Ber.*, **9** [2], 109 (1931). M.V.K.

Salmonsbury Camp, Gloucestershire. G. C. DUNNING. *Antiquity*, **5**, 489–91 (1931).—Types of pottery are illustrated. A.J.M.

Potsherds from the Transjordan Desert. ANON. *Antiquity*, **5**, 363 (1931).—Early Iron Age, Hellenistic, and Roman sherds were found. A.J.M.

BOOKS

Art in the Life of Mankind. Vol. 3. Greek Art and Its Influence. Vol. 4. Roman Art and Its Influence. A. W. SEABY. Vol. 3, vii + 110 pp. Vol. 4, vii + 109 pp. Batsford, London, 1931. Price, 5s per vol. Reviewed in *Times Lit. Supp.*, **30**, 983 (1931). H.H.S.

Archaeology of Roman Britain. R. G. COLLINGWOOD. 8 plates, 68 figures. Reviewed in *Antiquity*, **5**, 504–506 (1931); for abstract see *Ceram. Abs.*, **10** [5], 324 (1931). A.J.M.

Glass Paintings of Coventry and Its Neighborhood. B. RACKHAM. *Walpole Soc.* [Reprint], 19 pp. (1931); reviewed in *Notes & Queries*, **161**, 361 (1931).—The paintings date from the 14th Century. H.H.S.

Corpus of Dated Palestinian Pottery. J. GARROW DUNCAN. Reviewed in *Antiquity*, **5**, 393–94 (1931); see also *Ceram. Abs.*, **10** [9], 623 (1931). A.J.M.

Seventy Years in Archaeology. FLINDERS-PETRIE. 284 pp. Sampson Low, Marston & Co., London, 1931. Price, 18s. Reviewed in *Times Lit. Supp.*, **30**, 853 (1931).—The chronological equations in the history of Egypt, established by P. from a study of pottery and glazes, have long been accepted by scholars. H.H.S.

The Temple of the Warriors. EARL H. MORRIS. xii + 251 pp. Scribner's, 1931. Price $5.00. Reviewed in *Times Lit. Supp.*, **30**, 934 (1931).—The Carnegie Institution's work at the Maya city of Chichen Itza, Yucatan, is recounted. H.H.S.

Manual of Oriental Archaeology. (Manuel d'archéologie orientale.) G. CONTENAU. Published by Auguste Picard, Paris, 1931. Reviewed in *Antiquity*, **5**, 516–17 (1931). A.J.M.

Comechingon Pottery. G. A. GARDNER. *Proc. 23rd Intern. Congress Americanists* [Reprint], Sept., 1928.—An authoritative and voluminously documented paper is presented on the ceramics of the Comechingon peoples of Cordoba. A.J.M.

Foundation Figurines and Offerings. E. DOUGLAS VAN BUREN. xvi + 81 pp., 20 plates. Price, 40 M. Published by Schoetz and Co., Berlin, 1931. Reviewed in *Antiquity*, **5**, 397 (1931). A.J.M.

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Design for bottle. MAGGY BESANÇON DE WAGNER. U. S. 86,013, Jan. 19, 1932. EDWIN W. FUERST. U. S. 86,017, Jan. 19, 1932. ARNOLD H. HOLMES. U. S. 86,024, Jan. 19, 1932. RENÉ LALIQUE. U. S. 86,033, Jan. 19, 1932. CHARLES DAVIS LITTLE. U. S. 86,036, Jan. 19, 1932. HARRY JOSEPH LINSCOTT. U. S. 86,088, Jan. 26, 1932. RUDOLPH SAMUELS. U. S. 86,094, Jan. 26, 1932.

Design for cabinet range. JOE BROWN. U. S. 86,079 and 86,080, Jan. 26, 1932.

Design for gas or electric cooking range, etc. JACOB TELLER AND ARTHUR P. SCHULZ. U. S. 86,065, Jan. 19, 1932.

Design for tile block. BECHER B. BOLTON. U. S. 86,075 and 86,076, Jan. 26, 1932.

Method of and apparatus for automatically reshaping and decorating ware in the manufacture of pottery. WILLIAM J. MILLER. U. S. 1,842,622, Jan. 26, 1932.

Decorating ceramic products. PORZELLANFABRIK BAVARIA A.-G. Ger. 532,499, Oct. 9, 1930. Relief effects are obtained by decorating the glazed article with a pigment containing a flux, strewing it with quartz sand while the pattern is still moist, firing, and then mechanically removing the quartz in a known manner. (*C.A.*)

Cement, Lime, and Plaster

Portland cement specification. ANON. *Chem. Trade Jour.*, **89** [2323], 534 (1931).—The British Engineering Standards Assn. has issued a revised edition of the British standard specifications for Portland cement. The new specification contains the following modifications: (1) the elimination of the 28-day test for cement and sand mortar, the 3- and 7-day tests only being specified; (2) a new method for ascertaining the quantity of water to be used for gaging the tensile strength, setting time, and soundness tests; and (3) the reduction of the boiling time in the soundness test. M.V.K.

Chemistry of Portland cement. LENNART FORSÉN. *Acta Chem. Fennica*, **4**, 66–82 (1931).—A review of the theories of the constitution of Portland cement is given. The greatest lime limit for technical Portland cement clinker not containing free lime is given by the formula $3CaO + x(2CaO \cdot Fe_2O_3) + y(2CaO \cdot Al_2O_3)$. This formula is chemically explained by the formula for lime-saturated clinker, which is $3CaO \cdot SiO_2$ (alite $+ x(4CaO \cdot Fe_2O_3 \cdot Al_2O_3)$ (celite) $+ y(3CaO \cdot Al_2O_3 + 5CaO \cdot 3Al_2O_3)$ (eutectic glass)). When the clinker reacts with water, hydrates of Ca aluminate and Ca silicate are formed which are hydrolytically decomposed to a state of equilibrium. The silicates then form negative and the aluminates positive colloids. The rapid setting of the clinker powder (when no retarders are added) is due to the reciprocal coagulation of these positive and negative colloids according to Biltz's law. In the presence of retarders the aluminate component is precipitated from the solution as crystallized double salts $3CaO \cdot Al_2O_3 \cdot CaX_2 \cdot xH_2O$, where x may be sulphate (one-half mol.), Cl, Br, I, ClO_3, NO_3, NO_2, or OH. Normally the setting of cement begins with the formation and coagulation of the silicates as soon as the necessary concentration of Ca ions is reached. The addition to cement of compounds which combine with lime increases the strength of the cement. This removes the lime from solution and the solubility of the colloidal silicates is increased. The compounds that combine with lime in this way are $CaCl_2$, $AlCl_3$, $CaBr_2$, $Ca(NO_3)_2$, $3CaO \cdot Al_2O_3$ and $5CaO \cdot Al_2O_3$ (in variable quantities for the latter), forming lime-rich compounds of the type: $3CaO \cdot CaCl_2 \cdot 15H_2O$, $3CaO \cdot Al_2O_3 \cdot CaCl_2 \cdot 10H_2O$, $3CaO \cdot CaI_2 \cdot 15H_2O$, $CaO \cdot Ca(NO_3)_2 \cdot 3H_2O$, and $4CaO \cdot Al_2O_3 \cdot 13H_2O$. Constitutional formulas based on Werner's theory of coördination are proposed for the Ca silicates containing H_2O, for those free from H_2O, for the Ca aluminate hydrates, and for their double salts with lime. (*C.A.*)

True strength of Portland cement. KATSUZO KOYANAGI. *Rock Prod.*, **35** [3], 61 (1932).—K. states and presents figures to show that the strengths obtained by standard methods do not correlate with the concrete strengths of the same cements. The latter are more important. In Switzerland it is recognized that a bending test of a prism made of plastic cement mortar is more indicative of the concrete strength of the cement. Its adoption as a standard method for cement strengths is being considered. W.W.M.

Comparative tests with high-strength cements. ANON. *Ciment*, **36** [12], 459–60 (1931); *Pit & Quarry*, **23** [9], 63 (1932).—These comparative tests were carried on in concrete with three mixing proportions, five "super-cements," and one sample of fused alumina cement. Comparison of results at 2 days, 7 days, 3 months, 9 months, and 2 years leads to the following observations: (1) The differences in average strengths observed at 2 days, 7 days, 3 months, and 9 months are still found at 2 years. (2) The increase in strength between 9 months and 2 years seems essentially the same for all types of concrete no matter what the initial content of mixing water. (3) In the case of the samples of fused alumina cement, it was found that the differences in strength accompanying increased mixing water content in the lower periods were found again at two years. E.P.R.

Quick-setting silicate of soda cements for acid-proof tank and tower construction. F. D. SNELL AND H. FARKAS. *Ind. Eng. Chem.*, **23** [5], 525–29 (1931).—Silicate of soda cements for acid-proof tanks and towers are of three types: (1) inert material with sodium silicate, hardened by slow drying; (2) inert material with sodium silicate, hardened both by drying and by reaction to liberate silicic acid; and (3) a mixture of inert and alkaline or neutral material with sodium silicate, which by reaction will produce an insoluble silicate to give a set preliminary to drying. The neutral or alkaline self-hardening cements do not set hard initially and are therefore better able to take up the strains incidental to further building operations. Details of representative types of acid-proof lining construction are given. R.G.M.

By-product gypsum as retarder of cement setting. KATSUZO KOYANAGI. *Rock Prod.*, **35** [2], 32–36 (1932).—The effects of monocalcium phosphate on lime, calcium aluminate, and calcium silicate are discussed. K. concludes that the water-soluble phosphoric acid in phosphate gypsum, though small in content, disturbs the hydration of calcium aluminate. Data and photomicrographs are given. W.W.M.

Formation of calcium silicates in unset lime-sand mortar. H. BUNTZINGER AND W. BUBAM. *Z. anorg. allgem. Chem.*, **203** [1], 18–22 (1931).—The reaction of CaO and sand after long periods was studied by determining the soluble silica formed. The amount of soluble silica increases with increasing time and with decreasing particle size of the sand. The reaction takes place in the absence of CO_2 and therefore in the interior of the mortar. L.T.B.

Kiln-dust recovery at the Ford Motor Co. cement plant. E. H. DE CONINGH. *Rock Prod.*, **35** [2], 27–29 (1932).—Gas temperatures and pressures throughout the collecting system are shown on a chart, and chemical analyses of filter cake dust and clinker are given. The stack dust is collected and returned with the kiln feed, forming 2% of the total clinker produced. The dust collection is 98% efficient and 40 tons of raw material a day per kiln are saved. Illustrated. W.W.M.

Enamels

Defects in cast enamels, their causes and prevention. I. WALTER KERSTAN. *Emaillewaren-Ind.*, **8** [46], 366–67; [47], 375–78; [48], 382–84 (1931).—The chemical and physical properties of cast iron are of the greatest importance for good enameling. The iron must be (1) easily cast and molded, (2) fine-grained and dense but not hard and brittle, and (3) poor in oxides which decrease the adherence of the enamel. The behavior of iron during enameling must be known in addition to its shrinkage, expansion, refractoriness, and strength. Iron should be used in which graphite is present in a finely divided or eutectic form. The form of carbon and its distribution are important.

Silicon should be not less than 2.2% and not more than 2.6%. If more, it promotes a rich and coarse-grained precipitation of graphite which produces a poor adherence of the ground frit and bubbles and pores in the enamel glaze. Silicon also influences shrinkage and expansion. Manganese produces tensions. Sulphur makes the iron thickly liquid and its molding difficult; the cast becomes brittle, hard, and vitreous. Phosphorus does not directly affect the enameling, although a too high content produces brittleness.

M.V.K.

Coating, spraying, decorating, and firing of sheet enamels. WILHELM GREINER. *Sprechsaal*, **65** [2], 28–29 (1932).—The sheet ware to be enameled is heated to redness, pickled with hydrochloric or sulphuric acid, and washed in water and soda water. It is coated with a ground enamel consisting of the following frit: 37% borax, 24.6% feldspar, 21.3% quartz, 6.6% soda, 3.4% saltpeter, 5.7% fluorspar, 0.8% pyrolusite, 0.22% cobalt oxide, and 0.18% nickel oxide. Some soda is added to the mill. All sheet enamels should have a ground coat to bind them tightly to the metal. The object is immersed in the enamel or the enamel is sprayed on. After the object is dried, the ground coat is fired in a muffle kiln at 900 or 1000° for 3 to 5 min. The composition of the second enamel is different. The compositions of a white enamel and a colored enamel are given. After the object is coated with the second enamel, it is dried and fired. In cases of complicated decorations where several colors and gold are combined, the object is fired several times at lower temperatures. The decorating processes are described.

M.V.K.

Economy of sheet metal in objects to be enameled. W. GREINER. *Glashütte*, **62** [1], 8–9 (1932).—When the drawing method is used, the loss in sheet metal for objects to be enameled amounts to 15 or 20%. This is lowered by using an appropriate welding method. Thinner metal sheets may be used and either autogenic or electric welding can be employed. The welding seams are not visible because of the enamel. M.V.K.

Colored enamels. ANON. *Glashütte*, **60**, 828–30 (1930); *Glastech. Ber.*, **9** [2], 118 (1931).—Rules are given for preparing colored enamels. The pigments most used are pure metal oxides. It is necessary to test them for soluble salts and to determine the resulting color by sample melting. An enamel can be colored by fusing the pigments in or by addition to the mill. The first way is better. During the fusing in of coloring agents, changes in the physical properties of the enamel take place. These are fewer, the less pigment is added. It is better, therefore, to use more expensive pigments with a higher intensity than cheap pigments with a weak coloring power. Colored enamels should be melted in special kilns or drop crucibles, and with fine colors they should be covered. Of greatest importance is the thorough mixing of the pigments with the enamel batch before melting. The kiln atmosphere must be oxidizing. Colors which are added to the batch as salt solutions must be converted into an insoluble form by precipitating with ammoniac or soda lye to avoid irregularities during drying. M.V.K.

Fluorides used in the glass and enamel industries. H. J. KARMAUS. *Sprechsaal*, **65** [1], 8–9 (1932).—Raw materials containing fluoride are used in opaque glasses and white enamel. These materials are cryolite, synthetic cryolite, sodium fluosilicate, and fluorspar. Meyer and Havas (*Sprechsaal*, No. 1 (1911)) found that (1) the volatilization of fluorine during melting of glasses and enamels depends on the melting time, temperature, and especially on the nature of the fluorides used, and (2) the kind of glasses or enamels (high or low silica content) has practically no influence on the quantity of fluorine lost. They also found that natural mineral cryolite loses 9% fluoride during firing; synthetic cryolite, 14%; fluorspar, 17%; and sodium fluosilicate, 50%. Mineral cryolite differs from synthetic in specific gravity, which is 1.5 and 1.0, respectively, and in luster and transparency. This difference in structure produces different chemical reactions. Raw materials containing fluorine are not only opacifiers but they also lower

the melting point considerably because of the formation of complicated eutectics. The flux action or melting point of different fluorides cannot be calculated exactly but seems to depend on the alkali content. Sodium fluosilicate begins to decompose into sodium fluoride and silicon fluoride at over 200°. Silicon fluoride is volatile, while sodium fluoride begins to melt at 990°. Mineral cryolite melts at 1000° without previous decomposition. The opacifying action of sodium fluosilicate depends first on the other components of the batch, on the alumina and zirconium oxide, and on the alkali and alkaline-earth content. In such batches, however, the silica content should be as low as possible. These two factors (high alkali and alkaline-earth content and low silica content) are difficult to combine with other requirements for a good enamel. Such enamels have too high a coefficient of expansion which decreases the thermal resistance and the hydrolytic adherence (strong attack of water solutions). It is claimed that sodium fluosilicate promotes a good luster in the enamel. A substance which gives luster cannot be a good opacifier, however, because opacity and luster are opposed although they are definitely related to each other. Enamels opacified by sodium fluosilicate are sensitive owing to (1) the volatilization of fluorine depending on the temperature and fusing time, (2) the fact that sodium fluosilicate attacks the furnace lining, and (3) the soiling of the melt by the grog from the lining. The grog particles are dissolved by the melt and its composition changes. Cryolite enamels attack refractory linings much less. M.V.K.

Quartz. ANON. *Emaillewaren-Ind.*, **8** [52], 413–14 (1931).—Quartz or silica is one of the main constituents of enamels. Its chief impurity is iron oxide which colors the enamel and is undesirable. Quartz is a refractory whose fusing point lies very high. It is important, therefore, to grind it as finely as possible to enable the fluxes of the enamel to decompose it easily and to form a homogeneous mass. For fritted ground-coat enamels for cast iron, quartz sand should be coarse. The silicate formed by silica and alkalis (sodium, potassium) is soluble in water and only with the addition of lime, magnesia, or barium does it become an insoluble silicate. Quartz lowers the expansion of the enamel and does not affect its elasticity. With a definite addition of fluxes the melting point of quartz is lowered, but to not less than 700°C. Silica is a weak acid at low temperatures but becomes a strong one and is able to set free all other acids at high temperatures. This is due to the fact that at high temperatures silica does not volatilize. Quartz should contain at least 99% silica and less than $^1/_2$% Fe_2O_3. M.V.K.

Pipe clay. ANON. *Emaillewaren-Ind.* (*Émail*), **8** [52], 67–68 (1931).—A good pipe clay should have (1) high suspension power, (2) high adhesive power, causing the liquid enamel to stick to the object, and (3) it should not be too fat and should not crack during firing. It is impossible to ascertain the value of pipe clay for enamels by analysis or by studying its suspension. Pipe clay cannot be used for majolica glazes. M.V.K.

Approved opacifiers. WALTER OBST. *Emaillewaren-Ind.*, **9** [3], 17–20 (1932).—O. discusses patent literature and the opinions of different investigators on the opacifying power of different substances. M.V.K.

Removing enamel. II. ANON. *Emaillewaren-Ind.*, **8** [48], 61 (1931).—The third method used for removing enamel is with caustic soda. It is melted and the pieces from which enamel is to be removed are immersed in the liquid. In about 20 to 30 min. the enamel has disappeared. This method is efficient and cheap, although there is some danger because the hot liquid may produce deep burns in the skin and if humidity enters the bath, it causes an explosion. This process has recently been improved and is carried on in autoclaves under a certain pressure. For Part I see *Ceram. Abs.*, **11** [2], 81 (1932). M.V.K.

Powdering bathtubs. OSKAR KERSTAN. *Glashütte*, **61** [51], 932–33 (1931).—K.

discusses the waste in enamel when powdering bathtubs, describes two arrangements to prevent this loss, and gives economy data. M.V.K.

Semi-rotary furnace for frit melting. J. McKimmell. *Pottery Gaz.*, **57** [656], 224–25 (1932).—After discussing the causes of the high production cost of the older types of coal-fired frit furnaces, the advantages of the new semi-rotary oil-fired frit kiln are enumerated. The new furnace consists of a steel barrel mounted on rollers and rotated through reducing gears by means of a handwheel. The refractory lining is a specially prepared rammed material, and firing is done by applying an oil burner at each end. The furnace can be adapted to gas firing. The simplicity of relining, space economies, adaptability of the furnace to small batches, and ease of operation are some of the advantages. E.J.V.

Continuous electric enameling furnace. Westinghouse Electric & Mfg. Co. *Ceram. Ind.*, **18** [2], 131 (1932).—This furnace produces about 1500 sq. ft. of sheet ware per hour. The unit is approximately 40 ft. long overall and is designed to operate at a chain speed of 4 to 5 ft./min. It is equivalent to about 2 box furnaces. W.W.M.

Enamel shop tests for soda and sulphuric strength. Anon. *Ceram. Ind.*, **18** [2], 130 (1932).—Methods are given for preparing and standardizing the soda and sulphuric cleaning and pickling solutions for use in the shop. W.W.M.

Equipment for the cleaning of metal. XIII. R. W. Mitchell. *Metal Cleaning & Finishing*, **4** [1], 15–19 (1932).—The topic of cleaning solution agitation is continued. Descriptions of operation and data on both centrifugal and rotary pumps are presented. Illustrated. For Part XII see *Ceram. Abs.*, **11** [3], 161 (1932). E.J.V.

Special metals in the vitreous enameling industry. R. J. Williams. *Ceram. Ind.*, **18** [2], 132 (1932).—The use of special metals for enameling furnace fixtures is discussed. Various types of fixtures are described and illustrated. W.W.M.

Electric heat solves a foundry problem. Wm. B. Ferguson. *Maintenance Eng.*, **90** [1], 12–13 (1932).—Electric heating coils are used to heat patterns in a molding machine to prevent the molding sand from sticking to the patterns. Illustrated. J.L.G.

The enamel plant as a research laboratory. A. I. Andrews. *Ceram. Ind.*, **18** [2], 87–88, 128 (1932).—Some research work in enameling cannot be done in the laboratory and therefore certain production problems must be developed in plant routine. A. cites many instances where the technical man in the enameling plant can do valuable research work. W.W.M.

Mechanical house. Anon. *Bldg. Supply News*, **42** [2], 89–93 (1932).—A house constructed of enameled sheet steel is now being developed. Fabricated sheet-metal studs with a center-to-center distance of 16 to 36 in. form the shell of the building, and wall units are in the form of rectangular shallow panels backed with a cellular or fibrous board. By a special process of bolts and battens the porcelain sheets are firmly held to the studs, an applied batten sealing the joints from the weather. A special form of shiplap is used for permanent joints. Plaster can be applied to insulated board or metal lath on the inside and an insulating material is used as a filler in hollow parts of the wall. Floors are of steel. Kitchens, bathrooms, and lavatories have walls of enameled tile and the roof is of porcelain-steel shingles. The cost of the house is slightly lower than that of frame construction. Rapid construction is the outstanding feature. E.C.C.

Blackboards of porcelain enamel made on a commercial basis. W. K. Friend *Ceram. Ind.*, **18** [2], 112–15 (1932).—F. states the problems encountered and overcome in the development of porcelain enamel blackboards. It was necessary to eliminate the orange-peel texture, gloss, and smoothness. A glossy finish and a suitable abrasive for removing the smoothness are used and the gloss is removed by etching with acid. The resulting blackboard is lighter in weight, more durable, more easily cleaned, more

permanent in color than other boards, fits tightly against the wall, and has no rough joints. W.W.M.

BOOK

Stamping and Enamel Calendar, 1932. ANON. Verlag Ztg. Blechind., Leipzig, 1931. 272 pp. 3.30 Rm. Reviewed in *Emaillewaren-Ind.*, **8** [52], 415 (1931); *Sprechsaal*, **65** [2], 36 (1932).—The first part of the book deals with stamped ware and machines used for stamping. The second part is devoted to enameling and gives (1) a review of the literature of the last few years, (2) tables with the properties of raw materials and data calculations, (3) the influence of different properties of cast iron on enamel, and (4) the testing of enamels (chemical and physical investigations). M.V.K.

PATENTS

Tiled wall, etc. OWEN E. GRIGSBY. U. S. 1,841,370, Jan. 19, 1932.

Translucid enamels for cast and sheet iron. SOC. MIGEOT FRÈRES. Fr. 707,143, March 11, 1930. Fe, which has a particularly low fusibility, has its constituents limited in the following manner: boric anhydride 10 to 23, Ba or Sr 5 to 25, K 3.5 to 19, SiO_2 4 to 13, Zn 0 to 23, Ca 0 to 10, Al_2O_3 0 to 3, and F 0 to 3%. The enamel is applied by heating the article to redness and powdering the enamel thereon so that it immediately melts. (*C.A.*)

Glass

Manufacture and characteristics of laminated glass. WILLARD L. MORGAN. *Ind. Eng. Chem.*, **23** [5], 505–508 (1931).—Nitrocellulose has been used chiefly as the plastic sheet, although in Europe cellulose acetate has been utilized to a small extent. The major portion of all laminated glass has been made by using a film of gelatin on the interior glass surfaces to secure adhesion of the celluloid. The gelatin, however, was not used as an ordinary wet glue, but in a dry form which became adhesive due to thermoplastic flow under heat and pressure. For standard quality laminated glass the production methods are as follows: Glass sheets are cut to size by means of metal templates. Each piece of glass is wiped on one side by hand with a cleaning solution and is placed on a conveyer which carries it through a washing machine with a series of revolving brushes and then into a drier. Emerging from the drier, the glass sheets are sprayed with a dilute solution of gelatin by means of an automatic device which moves a spray nozzle back and forth at right angles to the direction of motion of the conveyer. The celluloid sheets, cut to size, are placed on the glass and carried through another automatic spraying apparatus where the celluloid is sprayed first on one side and then on the other with a mixture of plasticizers and high-boiling solvents to soften the surface slightly. The other glass is then laid on top. Because of the danger of contamination of dust and dirt, the conveyers are covered from the washing to the assembly rooms. The rooms are continually supplied with fresh air which has been washed and filtered. The room in which the pressing operation occurs is vacuum-cleaned twice daily. The assembled sandwiches of glass travel to the press room where they are pressed two at a time between sheets of heavy paper, first with a relatively low pressure followed by a high pressure. Both surfaces of the press are steam-heated. The pressing is generally carried out at from 200 to 260°F for from 6 to 20 min. with final pressures ranging from 150 to 350 lb./sq. in. After pressing, each sandwich has the celluloid removed approximately $^1/_8$ in. in from the edge to form a slot which is then filled with a waterproof-

ing pitch to seal the edge against atmospheric moisture. The edges are then ground and the sheets are inspected and wrapped for shipment. R.G.M.

Safety glass. HUGO KÜHL. *Glashütte*, **61** [52], 947–48 (1931).—K. reviews the literature devoted to safety glass and discusses the influence of compounds such as barium oxide, magnesium oxide, boric acid, antimony oxide, and aluminium oxide on the elasticity and tensile strength of glasses. M.V.K.

Modern research on glass. T. C. CRAWHALL. *Discovery*, **12**, 398–401 (1931).—Armor-plate glass, laminated glass, and glass silk are among the latest developments. Theoretical considerations include the nature of glass and the chemical and physical factors which influence durability. H.H.S.

Using photocells with a confining layer in glass technical laboratories. B. LANGE. *Sprechsaal*, **64** [53], 993 (1931).—The comparably large "photocurrents" of the cells with a confining layer of 1 mA per lumen permit the exact determination of the spectral absorption, opacification, and reflection of glasses with ordinary means. The distribution of light of opal glasses or bell glasses may be easily ascertained with a cell with a confining layer and a galvanometer (millivoltmeter) without additional mediums. In spectrum photometric measurements, it is necessary to measure the light flow for the separate regions of the spectrum with and without an absorbing medium. Because the "photocurrent" is directly proportional to the power of illumination, the proportion of both galvanometer swings gives the permeability. The exactness of these measurements depends on the spectral purity of the monochromator and the sensitiveness of the measuring instruments (mirror galvanometer). By this method, the fine structure of a neodymium glass can be easily measured. In contrast to visual photometric measurements, light absorptions of fractions of 1% can be exactly determined, and by this means the spectral permeability of optical glasses can be determined, and the influence of the addition of decolorizing substances may be quantitatively ascertained. The same spectrum photometric method can be used for determining the dependence of the absorption on the temperature. Finally, the course of absorption can be determined photographically with an ordinary spectrograph so that the spectral course of blackening can be ascertained with a new simplified photo-electric plate photometer. Because the great exactness of the spectrum photometric measurements described is not required in the laboratory, L. described a simple method for measuring the reflection and absorption in opaque and colored glasses. The apparatus is put over the measuring body and the "photocurrent" is read on a millivoltmeter; in this way ordinary comparison measurements can be made. By using a photo-electric colorimeter and two cells, the exactness of measurements is increased, and small amounts of coloring substances such as iron and manganese are easily determined quantitatively. M.V.K.

Specific heat of glass melts. H. WAGNER. *Sprechsaal*, **64** [53], 993 (1931).—Little is known about the specific heat of technical glasses. Without a knowledge of the temperature course of the specific heat, it is impossible to calculate the heat balances in glass kilns. W. investigated the specific heat of some types of bottle glass. Because of the dependence of the specific heat on the temperature, it is indispensable to differentiate between the mean specific heat and the real specific heat. The relation between the mean and real specific heat results from $c = \frac{di}{dT}$; $\bar{c} = \frac{i}{T_2 - T_1}$; $i = \int c \cdot dT$; $i = \bar{c}(T_2 - T_1)\,\bar{c} = \frac{T_1 \int^{T_2} c \cdot dT}{T_2 - T_1}$; where c is the real specific heat; $\bar{c}$, the mean specific heat; i, heat content; and T, temperature. If the mean specific heat of T_1 is present as a function of temperature, then the heat content of the unit of mass of the substance between the temperature T_1 and another higher temperature can be calculated from

the relation $i = c(T_2 - T_1)$. For the heat content between 2 optional temperatures, T_2 and T_3, higher than T_1, $i = c_3(T_3 - T_1) - c_2(T_2 - T_1)$, in connection with which the indices 2.3 for the c-values show that the mean specific heat belongs to the corresponding upper temperature. The specific heat of the glasses investigated was measured with the help of a special calorimeter and is described. The mean specific heat of 3 kinds of bottle glasses measured at temperatures beginning with 18°C up to 1300° are tabulated and show that the measuring point at 1100° lies very low in comparison with the measuring points at 900° and 1300°. This is due to the more or less strong devitrification undergone by the glass samples at 1100°. M.V.K.

Melts of technical glasses. W. WEYL. *Sprechsaal*, **64** [53], 992–93 (1931).—A series of reactions appears during the escape of gases in the melting of a glass batch. These approach a definite equilibrium, the state of which depends on the melting temperature and the partial pressure of different gases in the kiln atmosphere. This relationship is observed in sulphate glasses because the equilibriums exist in them in such a way that they can be ascertained analytically from the determination of the SO_3 present. With carbonates, equilibriums are known between alkalis, CO_2, and SiO_2, but they are present in such a basic field that no conclusions can be drawn, although researches on the problem of "gases in glasses" have given many important clues. As a type of a reciprocal action between the melt and gas phase, the system alkalis–silicic acid–carbonic acid under a high CO_2 pressure was investigated. The increase of the CO_2 partial pressure on pressures up to 1200 atmospheres displaced the equilibrium toward the side of carbonates. It was possible, therefore, to investigate equilibriums in silica melts of high acidities and to study, in the field of technical glasses, those phenomena which affect equilibriums, *viz.*, (1) pressure, (2) temperature, (3) acidity of the melt, and (4) variation in alkalis: Na, K, and Li. It was determined that real chemical equilibriums must be reckoned with also in alkali silicates of high acidity and that the carbonate content depends on the partial pressure of CO_2 over the melt. Low temperatures promote the dissolving of CO_2. Usually, under equal conditions, potash silicates contain the most carbonate, Li silicates have the least, and Na silicates occupy an intermediate position. Sodium silicate glasses with a 20% Na_2CO_3 content were prepared and, under appropriate conditions, crystals of K_2CO_3 could be set free from a potash-silicate glass with a molar proportion $K_2O:SiO_2 = 1:3$. M.V.K.

Chemical reactions appearing in the melt of sodium-aluminum-borosilicate glass. M. A. BESBORODOV. *Glashütte*, **62** [1], 5–6; [3], 37–38; [4], 55–57 (1932); for abstract see *Ceram. Abs.*, **11** [1], 14 (1932). M.V.K.

Melting eleolite glass. A. I. ZHILIN. *Ceramics & Glass*, **7** [10], 14–19 (1931).—Z. describes the melting of eleolite (nepheline) glass. The results obtained are satisfactory and show that (1) the contents of CaO + MgO in the batch should not exceed 12%; (2) up to 15% Al_2O_3 may be introduced into the batch, although the best glass contains 12.5% Al_2O_3; and (3) the R_2O content should not be lower than 13.5%. M.V.K.

Optical and X-ray investigations on opaque fluoride glasses. WILHELM BÜSSEM. *Sprechsaal*, **64** [53], 993–94 (1931).—The nature of precipitations in opaque fluoride glasses was investigated. Their composition was as follows:

No.	SiO_2 (%)	Na_2O (%)	Varied oxides (%)	F in 100
1	72	18	10 Al_2O_3	5
2	78	12	10 ZnO	10
3	72	18	10 SrO	5
4	78	12	10 BaO	10
5	78	12	10 MgO	10
6	78	12	10 PbO	5

Large crystalline precipitations of two different kinds were found in the thin sections of the preparations. Within the precipitates of the main constituents whose crystals were of an average size and double refraction, an isotropic constituent very finely disseminated was set free. This was found with some variations in all glasses. A further optical investigation, especially the determination of the refractive index, was found to be impossible because the crystals were enclosed in the vitreous ground mass. Efforts were made, therefore, to identify these constituents by means of X-rays. The method of Debye-Sherrer was used although the preparations were slightly pulverized and not rotated in order to separate the lines of the coarse kinds of crystals from the fine. It was found that the lines of the coarse crystals were punctured and interrupted, while those of the fine crystals were homogeneous and uniformly blackened. It was possible, therefore, to separate and identify the separate lines. The coarse crystalline lines were found to be cristobalite and the others, sodium fluoride. The fact that in all cases, in spite of the different composition of the ground glass, similar precipitates were observed explains the results of the work of Gehlhoff, Kalsing, and Thomas (*Ceram. Abs.*, **10** [10], 683 (1931)) on the light technical properties of opaque glasses. The opacifying power of an opaque glass is proportional to the difference of the refractive index of the precipitates and that of the ground glass. The opacifying power changes proportionally to the refractive index of the ground glass because the crystalline constituents are alike in all cases. M.V.K.

Beryllium oxide in glass and porcelain. ANON. *Chem. Trade Jour.*, **89** [2324], 552 (1931).—A series of beryllium glasses was prepared and compared with the corresponding calcium and magnesium glasses. They were found to have a lower density and greater hardness. The transparency to ultra-violet light was greater than that of ordinary glass, but less than that of magnesium glass. The results indicated that the oxide may be useful in the manufacture of special hard optical glasses. Beryl has been used as a substitute for feldspar in the manufacture of spark-plug porcelains. When it replaces feldspar in amounts of 25 to 45% of the total mixture, the product has a high electrical resistance and low thermal expansion. Beryllium oxide has been suggested as a material for the manufacture of special refractory crucibles. It is a weaker base than magnesia and is more resistant to acids. M.V.K.

Baryta as raw material for glass. FAHDT. *Glashütte*, **59**, 753 (1929); *Ind. Silicati*, **8** [2], 9–10 (1930); *Glastech. Ber.*, **9** [2], 110 (1931).—F. discusses the properties which barium oxide gives to glass, the advantages of using baryta in a glass melt, data on the additions of baryta to the batch, preparation of precipitated barium carbonate, and use of barium oxide in different kinds of glass. M.V.K.

Determination of alkali in glass. R. D. SMITH AND P. CORBIN. *Ind. Eng. Chem.* [Anal. Ed.], **4** [1], 137–39 (1932).—The Sullivan and Taylor oxalate method with the additional use of 8-hydroxyquinoline is particularly suited for alkali determinations in borosilicate glasses and has additional uses in determining lime, alumina, and magnesia on the same sample. These determinations can readily be made in one day. Larger samples can be used for the alkali glasses and glasses containing small amounts of lime, magnesia, alumina, etc., in determining their oxides. The method is not recommended for glasses of over 5% alumina or materials of the feldspar class. Double precipitation of the oxalates and quinolates is recommended for accurate alkali determinations. This practice corresponds with that of the J. Lawrence Smith method in double precipitation or treatment of precipitates. R.G.M.

Notes on a method of determining the viscosity of molten glass. A. R. WOOD. *Pottery Gaz.*, **57** [656], 240 (1932).—The method used was that of testing the molten glass by the measurement of the falling motion of spheres inserted into it, the movement of the spheres being recorded by X-ray apparatus. E.J.V.

Testing the annealing of glass by means of optical examination. MARCEL BELLIÈRE. *Rev. belge ind. verrières*, **2**, 194–96, 218–20 (1931).—B. gives a complete review. A.J.M.

Chemically resistant glasses for laboratory apparatus. I. I. KITAIGORODSKI AND S. M. KUROVSKI. *Trans. State Inst. Testing Bldg. Materials & Glass*, **31**, 3–43 (1930); *Sprechsaal*, **65** [4], 68 (1932).—The purpose of the investigation was to manufacture a glass which would have the same properties as the Jenaer apparatus glass but a more simple composition and which could be manufactured under ordinary conditions. The following 5 glasses correspond to the requirements:

	SiO_2 (%)	B_2O_3 (%)	Al_2O_3 (%)	CaO, MgO (%)	Na_2O (%)
1	70	12	3	10	5
2	74	8	3	10	5
3	74	5.5	3	10	7.5
4	74	3	3	10	10
5	76	4	3	10	7

Glasses 3 and 4 were industrially melted at 1350° and were satisfactory with regard to their capability of resisting chemicals and thermal requirements. Sand, kaolin, dolomite, boric acid, soda, and saltpeter were used as raw materials. M.V.K.

Development of medicinal glassware. LUDWIG KROEBER. *Pharm. Ztg.*, **76**, 1165–66 (1931).—An account is given of the gradual improvement in glassware designed for chemical and pharmaceutical purposes, as the result of repeated testing. See also *Ceram. Abs.*, **10** [12], 833 (1931). (*C.A.*)

Residuals in the melting of commercial glasses. W. EITEL AND W. WEYL. Translated by S. R. Scholes. *Jour. Amer. Ceram. Soc.*, **15** [3], 159–66 (1932).

A note in the concept of brittleness. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **15** [3], 176–78 (1932).

Shrinking forces. RAPHAEL ED. LIESEGANG. *Sprechsaal*, **64** [42], 775 (1931).—L. discusses the studies of Hirata (*Sci. Papers Inst. Phys. Chem. Research* [Tokio], **16**, 172 (1931)) on different fissures obtained in glass plates treated in different ways and describes his own researches on this question. M.V.K.

Control of the batch. F. BAUER. *Glashütte*, **61** [52], 949 (1931).—B. emphasizes the necessity of an exact control of the batch for obtaining glass of good quality. M.V.K.

Control of manufacture by simple physical tests. ANON. *Rev. belge ind. verrières*, **2**, 196–97 (1931).—These tests (for glasses) are dilatation, specific gravity, softening point, and index of refraction. A.J.M.

Fundamentals in glass technology. IV. Various properties of glass. GEO. V. MCCAULEY AND C. D. SPENCER. *Ceram. Ind.*, **18** [2], 107–11, 134 (1932).—Density of glass as related to chemical composition is discussed, as are tenacity, elasticity, hardness, and thermal properties of glass. Optical properties are treated with reference to chemical composition. For Part III see *Ceram. Abs.*, **11** [3], 164 (1932). W.W.M.

Glass made from slag. C. A. BASORE. *Nat. Glass Budget*, **47** [37], 12 (1932); for abstract see *Ceram. Abs.*, **11** [3], 165 (1932). E.P.R.

Decoloration of white glass in tanks. ALEXANDER NADEL. *Glashütte*, **61** [51], 929–31 (1931).—The factors which influence the coloring of white glass are (1) nature of the glass and of the substances contained in the batch; (2) temperature of the melt, its fusing time, temperature of working, kind of firing, and atmosphere; and (3) temperature, time, and kind of cooling. The nature of decolorizing processes and the action of some decolorizers are explained. Glass fused in a tank should contain a higher

content of decolorizers than that fused in pots because (1) the atmosphere in a tank is more or less reduced, (2) the temperatures are higher than in a pot, and (3) the glass is directly exposed to a larger flame surface than that in a pot. M.V.K.

The form of cracks in bottles. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **15** [3], 171–75 (1932).

Résumé of a course in glassmaking. XIII. ANON. *Rev. belge ind. verrières*, **2**, 132–34 (1931).—Furnaces are discussed. **XIV.** *Ibid.*, **2**, 153–55 (1931).—Regenerators, coke-oven gas, oil, and electric heating are discussed. **XV.** *Ibid.*, **2**, 179–80 (1931).—Pot furnaces are described. **XVI.** *Ibid.*, **2**, 205–206 (1931).—Tank furnaces are discussed with emphasis on construction and dimensions. **XVII.** *Ibid.*, **2**, 227–28 (1931).—Heat exchangers and the yield of regenerative furnaces are discussed. The ports are also considered. For Part XII see *Ceram. Abs.*, **10** [11], 784 (1931). A.J.M.

Electrical hair trigger utilizing the elastic properties of glass. ANON. *Glass Ind.*, **13** [2], 34 (1932).—A new vacuum contact which makes use of the elastic property of specially annealed glass to cause the mechanical actuation of contacts sealed in vacuum is described both as to operating principle and application. Illustrated. E.J.V.

Action of the heat charge on the melting power and fuel consumption of tank furnaces. J. LAMORT. *Glastech. Ber.*, **9** [1], 30–35 (1931); *Chim. & ind.*, **26** [6], 1389 (1931).—The yield of a tank increases with increased heat charge according to an approximately linear law. A practical limit is soon reached, however, in furnaces of ordinary construction. In "neck tank furnaces" the heat charge can be increased to very high values which are proportionately near those of a Martin steel furnace. The coal consumption decreases with an increased charge but the life of the refractory linings in such furnaces is greatly lowered. Curves and diagrams illustrate the article. M.V.K.

Use of polarizing microscope in factory control. W. R. LESTER. *Glass Ind.*, **13** [2], 19–20 (1932).—The polarizing microscope equipped with a 32-mm. objective, a 7.5-power eyepiece, and a sensitive tint plate (red of the first order) is used to determine the manner in which the residual strain is distributed in the ware. By cutting a ring section from the ware to be examined and immersing it in a liquid whose refractive index is nearly the same as that of the glass, it is possible to observe either a dark field which remains unchanged on rotating the stage indicating no strain present in the glass, or a field of gray bands which become alternately light and dark on rotation indicating strained conditions in the glass. The changes observed when the tint plate is inserted are described for the various conditions present in the glass. The conditions indicated by the presence of cords are discussed. Illustrated. E.J.V.

Recording the level of glass in a tank. ANON. *Rev. belge ind. verrières*, **2**, 146–47 (1931).—One arm of a lever carries a refractory float which rests on the molten glass. The other arm carries a pencil which records the glass level on a special chart. A.J.M.

A simple operation in glassblowing. L. M. KEBRICH. *Chemist Analyst*, **20** [6], 23 (1931).—A method for making a bulb with perforations is described. The glass tubing with the bulb at the other end is connected with one arm of a Y-tube and the other arm is connected with a blow pipe. In this way the same blast of air directs a pointed flame against the previously heated bulb and at the same time creates pressure in the bulb. (*C.A.*)

Refractory stones in glass. A. BALESTRA. *Ind. Silicati*, **9** [8], 11 (1931).—Refractory stones are found in objects of glass fused in crucibles, especially after the latter have been subjected to the continued action of intensive fire and fused glass for a certain time. The stones are composed of "sillimanite" (Al_2SiO_5) and appear in the glass as small greenish transparent nodules. The presence of iron in refractory materials

promotes the formation of sillimanite and gives it the green coloring. The use of too much siliceous material for thinning the refractory paste renders the latter less resistant to the action of the fused glass and aids the formation of sillimanite. The refractory material must be carefully worked to render it homogeneous. Crucibles badly corroded after 10 or 12 weeks should be discarded. Fluorine compounds in the batch lead to the formation of sillimanite as do excess flux and too high firing temperatures.

M.V.K.

Manufacture of refractories for the glass industry in the U. S. P. P. BUDNIKOFF. *Ceramics & Glass*, **7** [10], 37–39 (1931). M.V.K.

Manufacture of rolled plate. XVII. ERNST LUTZ. *Glass Ind.*, **13** [2], 23–28 (1932).—In connection with the grinding and polishing of plate glass, L. discusses patents on clamps used for holding the glass on the tables, the old method of tipping the sheets by use of wooden frames, and the more modern method involving the use of a crane fitted with suction cups. Illustrated. For Part XVI see *Ceram. Abs.*, **11** [3], 168 (1932). E.J.V.

Progress of the glass industry. OSCAR KNAPP. *Glashütte*, **62** [2], 22–24 (1932).—K. discusses (1) silica determination in lead glasses according to Scholes (*Ceram. Abs.*, **9** [9], 788 (1930)); (2) decomposition of aluminous silicates according to Finn and Klekotka (*Ceram. Abs.*, **9** [8], 676 (1930)); (3) rapid determination of alkalis in glass according to Ritter (*Ceram. Abs.*, **9** [11], 978 (1930)); (4) determination of alumina according to Miehr, Koch, and Kratzert (*Ceram. Abs.*, **9** [10], 883 (1930)); (5) determination of the sulphate content in aluminium fluorides according to Ginsberg (*Ceram. Abs.*, **9** [7], 578 (1930)); (6) determination of boric acid in glass according to Dimbleby (*Ceram. Abs.*, **9** [9], 787 (1930)); (7) spectroscopic detection of fluorine according to Papish, Hoaf, and Snee (*Ceram. Abs.*, **10** [2], 150 (1931)); (8) determination of fluorine as calcium fluoride according to Carrier and Janssens (*Ceram. Abs.*, **9** [10], 882 (1930)); (9) determination of chrome oxide according to Scholes (*Ceram. Abs.*, **9** [8], 676 (1930)); (10) determination of manganese, iron, and aluminum in the presence of phosphoric acid according to Teletov and Andronikova (*Ceram. Abs.*, **9** [9], 786 (1930)); (11) colorimetric determination of tin according to Hansen (*Chem.-Ztg.*, p. 143 (1930)); (12) qualitative detection of zinc according to Pierce and Nave (*Ceram. Abs.*, **9** [11], 985 (1930)); (13) determination of magnesia in glass according to Pierce and Geiger (*Ceram. Abs.*, **9** [11], 977 (1930)); and (14) microchemical detection of zinc in glasses (*Ceram. Abs.*, **10** [7], 489 (1931)). M.V.K.

Researches on the acid polish (brilliant etching) of lead crystal glasses. A. DIETZEL, A. TIELSCH, AND L. ERNYEI. *Sprechsaal*, **65** [1], 5–7; [2], 27–28 (1932).—The influence of different factors on the brilliant etching (acid polish) of matted potash-lead crystal glasses was determined. The glass was melted in a Fletcher kiln and cast into plates; these were frosted by hand on one side. (1) The glass composition was varied between 20 and 60% PbO with corresponding potash and silica contents. It was found throughout that glasses rich in lead (poor in silica) take the polish much more rapidly than those poor in lead and that the luster obtainable is generally much stronger in glasses rich in lead. (2) The acid mixture varied between the two limits: 100 vol. % HF (40%) and 50 vol. % HF, and 50 vol. % H_2SO_4 (95 to 98%). It was found that an optimum is obtained almost independent of the glass composition with a proportion of about 4 parts of HF (40%) to 1 part H_2SO_4. (3) The action of diluting the acid in glasses with a different PbO content was as follows: The more PbO contained in the glass, the more water can be added to the concentrated acid mixture without lengthening the time of etching in comparison with that of an acid mixture free from water. The limit to the amount of water which can be added without markedly increasing the etching time can be calculated according to the following formula: $WZ_{10}^{\circ} = 2\cdot(\%PbO - 10)$,

where $WZ_{10}°$ is the addition of water in cubic centimeters to 100 cc. of the concentrated acid mixture (HF, 40%; H_2SO_4, 95 to 98%) for a bath temperature of 50°. Any amount of water can be used up to this limit to diminish the injurious acid vapors without decreasing considerably the velocity of polishing. To obtain a better control through slower polishing, this limit should be exceeded. (4) The higher the temperature of the bath, the more rapidly does the brilliant etching work under otherwise equal conditions. The use of baths of higher temperatures than 50 or 60° is limited because of the development of acid vapors. (5) The observation was made that streaks which were previously invisible appeared on the fire-polished side of the glass sample.

M.V.K.

Yellow etching of glasses. II. WALTER HEINRICH. *Sprechsaal*, **64** [48], 890–92; [49], 915–17; [50], 932–35; [51], 551–53; [52], 971–74 (1931).—The results of the researches are as follows: (1) The temperature of the yellow etching depends on the kind of glass, the kind of the silver salt in the paste, and the concentration of the paste. (2) Increasing the firing temperature above the softening point of the glass deepens the color slightly. With a very high temperature, however, a deformation of the glass and an opalescence take place. (3) A lengthening of the firing time with a constant temperature does not deepen the color tone. (4) Silver chloride is the most suitable form for obtaining the purest and deepest color of etching. Next come silver oxide, silver sulphide, and silver nitrate; metallic silver should not be used. (5) A paste concentration of 1:10 up to 1:5 may be used in practice. (6) Arsenic glasses are especially adapted for yellow etching, and the deepening of the color increases with the increase in the arsenic content. (7) Flue gases have a favorable action on the development of the color during firing. (8) The use of fired or unfired ocher is not important. (9) Iron sulphide deepens the color tone, while iron oxide in the etching paste exerts only a weak influence on the color. (10) Opalescence appears at 20° over the visible softening point of glasses. (11) The average depth of penetration of the silver coloring into the glass was found to be 0.16 mm. (12) The average silver content of the color layer was analytically determined. (13) The problem of preparing yellow etchings in different color tones is solved (*a*) through the introduction of increasing quantities of arsenic in the glass batch, (*b*) by the combination of the resultant glasses with etching pastes of different concentrations, (*c*) by an eventual use of the influences of flue gases during firing, and (*d*) by additions of certain reducing agents into the paste. (14) The colors obtained are from light yellow to brown. (15) The various colors formed are due to the reducing action of different substances, and the difference in color tones is due to the kind of accumulations of silver nuclei. (16) Glasses containing arsenic are considerably decolorized by sunlight. For Part I see *Ceram. Abs.*, **11** [3], 169 (1932).

M.V.K.

Amethyst and smoke coloring of quartz. J. HOFFMANN. *Z. anorg. allgem. Chem.*, **196**, 225–46 (1931); *Sprechsaal*, **64** [45], 833 (1931); *Sitzber. Akad. Wiss. Wien, Abt. IIa*, **140**, 11–26 (1931).—Decolorized natural amethyst and smoky quartz regain their natural colors when exposed to β and γ rays and it must be assumed, therefore, that they are the natural colors of exposure. The exposure coloring of silicates and quartz glasses is the same. The smoky coloring can be observed not only in quartz containing iron and titanium ions but also in that free from iron and titanium. H. assumes that this coloring is due to the breaking up of quartz molecules through the influence of exposure. Because the amethyst pigment is free from manganese, the reason for the coloring is the ferrosoferric ions which are accompanied by detectable quantities of titanium and zirconium. The constitutional changes of the quartz cell bring about the amethyst coloring and its destruction. See also *Ceram. Abs.*, **10** [9], 633 (1931).

M.V.K.

Decorating glass by means of the sandblast. JACQUES WOLF. *Rev. belge ind. verrières*, **2**, 201–204 (1931).—Illustrated. A.J.M.

Durability and protection of silvered glasses. JACQUES WOLF. *Glass Ind.*, **13** [2], 21–22 (1932).—Most of the defects in mirrors have their source in an insufficient or unsuitable protection of the metallic silver. The principal condition for a resistant and durable silvered mirror is a faultless backing. Since the purpose of a covering coat on the back of a freshly silvered mirror is for the protection of the silver, not only against mechanical influences, but also against the chemical reactions from contact with the atmosphere, the requirements for a perfect protection coat are complicated: The coat must (1) have sufficient mechanical resistance to protect the mirror from scratches, shocks, etc., (2) absolutely isolate the silver from the influence of the weather, and (3) have a sufficient chemical resistance against atmospheric attack and normal physical circumstances. The materials forming the protecting coat must be without any chemical effect on the silver precipitate forming the metallic coat of the mirror. The protection coats worth considering for mirror finishing may be divided into two classes: (*a*) varnish coats and (*b*) protecting coats. The former are ordinarily employed in mirror fabrication as protecting and covering coats, while the latter serve rather as a special strengthening of the varnish coat in order to give it a higher resistance against atmospheric influences. Details of the constitution and application of both types of coats are given, and factors affecting each are discussed. See following abstract. E.J.V.

Dangers of explosion in silvering glass. JACQUES WOLF. *Rev. belge ind. verrières*, **2**, 224–25 (1931); for abstract see *Ceram. Abs.*, **11** [3], 167 (1932). A.J.M.

Ultra-violet permeability of sodium, potassium, and rubidium oxides in glasses. F. WEIDERT. *Sprechsaal*, **64** [53], 992 (1931).—The simple vitreous silicates of sodium, potassium, and rubidium were investigated and the coefficient of permeability of these oxides was determined. Photographic spectral photometry was the measuring method used, and a hydrogen tube with a continuous spectrum as the source of light. The testing glasses were prepared from the purest raw materials because the preliminary tests showed that the smallest quantity of impurities injures the ultra-violet permeability. The rays of permeability obtained show that K_2O is much more permeable to ultra-violet rays than Na_2O and Rb_2O_3 is the least permeable. A test with a lithium potassium silicate showed that Li_2O is sometimes the least permeable of the alkali oxides investigated. M.V.K.

Artificial solarization of ultra-violet glasses. B. SEMEIKIN AND A. CHEKIRDA. *Ceramics & Glass*, **7** [10], 40–41 (1931).—Several glasses were subjected to artificial solarization by rays of a quartz lamp. The measurements were made in the interval from 340μ to 270μ and were controlled by the Winter method. Data on the results are tabulated. M.V.K.

Heat transfer through glass panes. M. HOTTINGER. *Gesundheits-Ing.*, p. 41 (1929); *Glastech. Ber.*, **9** [2], 116–17 (1931); *Ceramics & Glass*, **7** [10], 44 (1931).—G. discusses sun radiation through glass panes and means of avoiding it as this sometimes produces an undesirable action. M.V.K.

Use of "Lustraglass" in schools and institutions. ANON. *Amer. Glass Rev.*, **51** [15], 24 (1932).—Less than two years ago the American Window Glass Co. announced "Lustraglass," a new violet-ray transmitting sheet glass, and up to the end of 1931 nearly 250 schools, hospitals, sanitoria, and institutions had been glazed with the glass. Throughout the country "Lustraglass" has been used in new buildings to be used largely by children and the sick. In addition, its use in homes and public buildings has increased steadily. E.P.R.

Glass as building material. ALMAZOV-MANEVITCH. *Ceramics & Glass*, **7** [7–8],

31 (1931).—A. discusses the ability of glass to harden on cooling and compares it to that of cement. The usual soda-lime glass cannot be used as building material because it lacks the necessary chemical stability and mechanical strength. A fused mixture of clay, dolomite, iron-beamed ore, and 2% phosphorite can be produced easily and, as all tests show, will have the required properties. This mass has a composition similar to cast basalt. See also *Ceram. Abs.*, **10** [2], 109 (1931). M.V.K.

Use of glass in modern construction. JACQUES WOLF. *Rev. belge ind. verrières*, **2**, 176–78 (1931). A.J.M.

Modern glass spinning. PAUL EICHHORN. *Glas App.*, **12** [20], 159–60 (1931); *Glastech. Ber.*, **10** [1], 45 (1932).—Glass spinning in Thuringia is now modernized and new fields for its use have been developed. Besides glass wool for insulating purposes and Christmas ornaments, glass-wool tapestry is manufactured. Glass wool (spun glass) is cemented in thin layers and interspersed with other threads. The colors obtained are remarkable. Glass felt panes for insulating purposes are also manufactured. M.V.K.

Exhibition of modern technical and artistic glasses at the Science Museum, London. ANON. *Proc. Soc. Glass Tech.*, **15** [59], 71–77 (1931); *Pottery Gaz.*, **56** [654], 1664–66 (1931); see also *Ceram. Abs.*, **11** [3], 152 (1932).

Pittsburgh Plate Glass Co. process of window glass manufacture. ANON. *Rev. belge ind. verrières*, **2**, 170 (1931).—Illustrated. A.J.M.

Technique of glassmaking in U.S.S.R. and abroad. I. I. KITAIGORODSKY. *Ceramics & Glass*, **7** [10], 10–13 (1931).—Raw materials, refractories, new glassmelting kilns, and the mechanization of glassmaking are discussed. M.V.K.

History of optical glass manufacture. ANON. *Rev. belge ind. verrières*, **2**, 171 (1931). A.J.M.

Swedish glass. ELSA E. TROMM. *Glashütte*, **62** [2], 21–22 (1932).—A historical review of the development of the glass industry in Sweden and a discussion of the present manufacture of artistic glass objects are given. M.V.K.

Glassmaking in medieval Italy. F. URBANI DE GHELTOF. *Ind. Silicati*, **9** [12], 12–13 (1931).—The best known glassmakers of Murano in the 17th Century are named. Because of the great number of inefficient glassmakers who were injuring the trade, Sebastiano Dall'Acqua assembled the leading tradesmen to raise the requirements of master craftsmen. See also *Ceram. Abs.*, **11** [2], 76 (1932). M.V.K.

Comprehensive study on glass. LOLA MAURAINE FOWLER. *Nat. Glass Budget*, **47** [39], 8 (1932).—The definition, materials, origin, early history, varieties, and the process of manufacturing glass are all of a questionable nature to most everyone. Glass, derived from an old Teutonic root "gla-," a variant of "glo-," and having the general sense of shining, glare, or glow, is a hard brittle substance consisting of mixtures of silicates of potash, soda, lime, magnesia, alumina, and lead, to which may be added other constituents for special purposes. It is prepared by melting certain of these materials together at high temperatures. From a liquid condition at high temperature, it is cooled with sufficient rapidity to become solid without changing its physical nature. The structure of glass has been the subject of repeated investigations. The theory most widely accepted at the present time is that glass is a super cooled liquid in which silicates, borates, phosphates, aluminates, etc., may be either solvents or solutes, depending on the proportions and the conditions under which the melting takes place. In addition, various metals and metal oxides may be held in suspension giving various effects as to color and physical properties. Examples of the essential materials of which this material is made are as follows: for English flint glass, sand and pearl ash (or carbonate of potash), and red lead; for plate glass and sheet glass, sand, soda ash (carbonate of soda), salt cake (sulphate of soda), and lime. In most cases more or less

cullet or broken glass is also added. The origin of glass manufacture is uncertain. Pliny states that the ancient Phœnicians accidentally discovered how to make it. Pliny actually recorded the discovery which effected the conversion of deliquescent silicate of soda into actual glass. He has so accurately recorded the stages of glass development that it may be assumed he had excellent reasons for claiming Syrians as the discoverers of glass. According to Egyptologists, the Egyptians made sham jewels of glass, as early as 6000 or 5000 B.C. In some of the most recent unearthed ancient tombs scarabs of glass imitation rubies, emeralds, sapphires, and other precious stones were found. These were so near perfect in the variance of color, pattern, fine workmanship, and exquisite beauty that they were often passed off by traders as jewels of great value. As a medium of trade, glass beads are evidently of great antiquity. The aggry beads have been attributed to both Egyptian and Phœnician sources and are highly valued by the natives. E.P.R.

History of glassmaking. ANON. *Amer. Glass Rev.*, **51** [17], 18 (1932).—Although the Chinese are said to have invented many of the articles in common use today, a historian of the glass industry says that "even the Chinese did not possess glass at any early time." The first glass blowers are thought to have been Egyptian artisans who, during the rules of the Ptolemies, fashioned flasks out of the same sort of mosaic glass they had used in beads for more than 2000 years. Glass was common in Roman times and was even used in a rudimentary way for optical instruments. A writer of the time described the use of a glass sphere filled with water to enlarge minutely-written letters. Hollow, colored glass balls have been found in which Roman women kept their cosmetics, which they spread on their faces with a twisted glass wand. Roman glass was made for about 400 years and in every country the Romans penetrated the glass trade was encouraged by exempting glassmakers from all personal taxes. The first centralized glass industry in America was in New Amsterdam, on Manhattan Island. The principal and essential constituents of glass are silica and an alkali. According to a writer on glass, "silica exists everywhere. Rock crystal, sandstone, and flint are composed of silica; it is also found in the ashes of plants, volcanic streams, and mineral springs. Sugar resembles glass, and this likeness is not deceptive. Melt the ashes of the sugar cane and you have glass; for with the silica they contain both potash and lime." E.P.R.

Development of window glass production. KARL DOPP. *Glashütte*, **61** [2], 21–22 (1931); *Glastech. Ber.*, **9** [2], 109 (1931).—The first window glass used was that found in the excavations of Pompeii. D. discusses also the machine production of window glass and shows the main differences in the Fourcault and Libbey-Owens systems. M.V.K.

BOOKS

Colloid Chemistry of Glass. R. E. LIESEGANG. 12 plates. Reviewed in *Rev. belge ind. verrières*, **2**, 158 (1931); for abstract see *Ceram. Abs.*, **11** [2], 95 (1932). A.J.M.

Mechanization of Glassmaking. L. GESBURG AND S. PERKAL. Reviewed in *Rev. belge ind. verrières*, **2**, 209 (1931); for abstract see *Ceram. Abs.*, **11** [1], 19 (1932). A.J.M.

Address Book of the Glass Industry, 1931. (Adressbuch der Glasindustrie, 1931.) ANON. 1000 pp. Price 15.50 Rm. Published by Sprechsaal, Coburg. Reviewed in *Rev. belge ind. verrières*, **2**, 182 (1931). A.J.M.

Waste Steam Boiler in Glass Works. ANON. Reviewed in *Feuerfest*, **7** [10], 154 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1115 (1930). M.V.K.

A B C of Glass and Enamels. (A B C für Glas und Email.) ANON. Published

by Die Glashütte, Dresden. Price 3 Rm. Reviewed in *Rev. belge ind. verrières*, **2**, 137 (1931). A.J.M.

Laboratory Handbook for the Glass Industry. (Laboratoriumsbuch für die Glasindustrie.) L. SPRINGER. 160 pp. Price 7.80 Rm. Published by Wilhelm Knapp, Halle, 1925. Reviewed in *Rev. belge ind. verrières*, **2**, 231 (1931); see also *Ceram. Abs.*, **10** [12], 835 (1931). A.J.M.

Book Review

Tables for Glass Technology: Physical and Chemical Constants of Glass. (Glastechnische Tabellen: Physikalische und Chemische Konstanten der Gläser.) Edited by W. EITEL, M. PIRANI, AND K. SCHEEL. Published by Julius Springer, Berlin, 1931. 714 pp. 8 x 11 in. 149.80 Rm. This monumental compilation is the outcome of a coöperative effort by a group of sixteen German glass technologists, in addition to the editors. They were financed by the German Society of Glass Technology and were given access to material in the unpublished records of the more progressive laboratories of manufacturers and technical institutions. They were also allowed to draw upon the authoritative tables of Landolt-Börnstein.

Any review of this ambitious and magnificent volume must be colored by the reviewer's admiration for it as a piece of bookbuilding. In size and format it corresponds with the famous Landolt-Börnstein from the same publisher. Four sizes of Latin type add beauty to the pages. Box-rules inclose each page. Vertical rules separate the columns of the hundreds of tables. The numerals are clear and uniform in size, and there is no crowding. References to authorities and original sources are many and definite. There is an adequate subject index.

The many curves have been redrawn by excellent draftsmen so that they are as nearly uniform in style as possible and add to the artistic beauty of the work.

The book is introduced by three prefaces which set forth the conception of the work and the manner in which the data were collected and the publication was made, the assignment and classification of the material, and suggestions for the practical use and technical application of the tables.

There are three main divisions of the book: The first deals with "Equilibria in Glass-Forming Systems," beginning with general information as to the glassy state and its equilibria with crystalline phases, discussing the oxides which are vitreous *per se*, the systems of the borates, carbonates, phosphates, and silicates as glasses, treating the silicates under two-, three-, four-, and higher-component systems, and finally and briefly, the organic glasses.

The second division, occupying three-fourths of the book, is a mine of data on the physical and chemical constants of glasses. Thirty-four headings are listed and evidently no investigated properties have been omitted. We find here not only the familiar properties listed by Hovestadt, such as density, elasticity, and thermal expansion, but a series of tables dealing with the effect of variation of composition upon properties rendered important by the recent applications of glass. Among these are various electrical properties and transparency to light of ordinary and extra-spectral wavelengths. One hundred pages are devoted to the behavior of glasses toward attack of chemical reagents and moist air. Emphasis is laid throughout on the functional dependence of properties upon composition.

The third section of the book consists of a catalogue of glass compositions. Distinction is made between laboratory melts and commercial glasses. Percentage compositions are given in detail, together with references to the tables in the second part of the book which set forth the most essential and interesting physical properties for the given

types of glass. The glasses are classified in nine groups, from the simplest to the most complex.

This section serves not only as a catalogue of hundreds of compositions that have been made commercially or in laboratory melts, but also as a reference list for use in connection with the tables of constants forming the main body of the book. It is safe to say that nowhere else in the literature of glass has any such compilation of glass compositions been made.

It would be manifestly impossible, in building this compendium, to deal critically with the published data of so many researchers. All that could be done was to include what has been accepted by the journals, giving the authors' names and, very briefly, their methods, leaving the reader to accept the greater and lesser authorities as he knows them by reputation. Thus it necessarily comes about that not all the tables and curves are of equal value and accuracy. But at least few contributors of physical data to the development of modern glass technology can complain of the omission of their work.

The most amazing thing about this volume is its very accomplishment in a year of world depression and in a country whose financial condition is of deep concern to the other nations of Europe and to America. We are compelled to admire and to congratulate the editors and their staff, and those whose support made the publication possible. And we are led to inquire why more of the wealth produced by the ceramic industries of America cannot be devoted to similar encyclopedic contributions to ceramic technology.

S.R. SCHOLES

PATENTS

Cylindrical tank furnace. HAROLD M. BLACK. U. S. 1,841,464, Jan. 19, 1932.

Method and apparatus for producing sheet glass. FRANK FRASER. U. S. 1,841,527 and 1,841,579, Jan. 19, 1932.

Apparatus for producing sheet glass. WILLIAM E. NOBBE. U. S. 1,841,548, Jan. 19, 1932.

Method and apparatus for producing sheet glass. JOHN L. DRAKE. U. S. 1,841,576 and 1,842,078, Jan. 19, 1932.

Method and apparatus for drawing sheet glass. FRANK FRASER AND WILLIAM E. NOBBE. U. S. 1,841,580, Jan. 19, 1932.

Width-maintaining means for sheet-glass apparatus. LUKE C. MAMBOURG. U. S. 1,841,660, Jan. 19, 1932.

Apparatus for producing laminated glass. GEORGE B. WATKINS. U. S. 1,841,689, Jan. 19, 1932.

Sheet-glass apparatus. CARROLL CONE. U. S. 1,841,714 and 1,841,715, Jan. 19, 1932.

Heat-absorbing means for sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,841,-716, Jan. 19, 1932.

Glassmelting furnace. JOHN L. DRAKE. U. S. 1,841,717, Jan. 19, 1932.

Glass-surfacing apparatus. FRANK FRASER. U. S. 1,841,724, Jan. 19, 1932.

Apparatus for sealing laminated glass. PAUL C. LAWSON. U. S. 1,841,745, Jan. 19, 1932.

Glassworking apparatus. FRANK G. NELSON, JR. U. S. 1,842,279, Jan. 19, 1932.

Process and apparatus for producing sheets of glass. JOHN L. DRAKE. U. S. 1,842,511, Jan. 26, 1932.

Glass. ZOLTÁN VON VERESS. U. S. 1,842,772, Jan. 26, 1932.

Leer loader. WILLIAM L. MCNAMARA. U. S. 1,842,912, Jan. 26, 1932.

Means for feeding molten glass to rolling apparatus for producing continuous glass strips. ERNEST BRISTOW LE MARE. U. S. 1,843,033, Jan. 26, 1932.

Manufacture of nonsplintering glass, so-called safety glass. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 363,933 and 363,940, Jan. 6, 1932.

Method and machine for the manufacture of ampullas, etc. J. DICHTER. Brit. 364,211, Jan. 13, 1932.

Machine for gaging glass articles such as lamp bulbs. CORNING GLASS WORKS. Brit. 364,320, Jan. 13, 1932.

Glassmaking furnace. JEAN H. LEMAIRE. Fr. 683,056, Oct. 10, 1929 and Fr. 37,978, Jan. 29, 1930. (*C.A.*)

Glassmaking. AUGUSTE FOURLINNIE. Fr. 706,542, Nov. 26, 1930. In making glass or other vitreous materials, the vitreous mass is brought to a temperature which gives it sufficient viscosity and which is below the usual refining temperature. The mass is then submitted to centrifugation to remove bubbles of gas. An apparatus is described. (*C.A.*)

Continuously operating apparatus for introducing glassware into cooling boxes or pots. WILHELM BACKMANN. Ger. 532,196, Sept. 9, 1930. (*C.A.*)

Apparatus for subdividing an endless glass band. PITTSBURGH PLATE GLASS CO. Ger. 532,336, Dec. 28, 1929. (*C.A.*)

Apparatus for withdrawing measured quantities of molten glass. JOSEPH SCHÄFERS. Ger. 532,440, Dec. 23, 1928. (*C.A.*)

Apparatus for simultaneously withdrawing a number of batches of molten glass. JOSEPH SCHÄFERS. Ger. 532,441, Aug. 13, 1929. (*C.A.*)

Structural Clay Products

Controlling efflorescence on building brick. IRVING KASS. *Ceram. Age*, **18** [2], 85–86 (1931).—K. estimates that 60% of the cases of efflorescence are due to causes over which the manufacturer has no control. There are three important factors governing efflorescence: (1) the quantity of water-soluble anhydride, (2) total solubility, and (3) percentage absorption. A special waterproofing has been designed to mix with mortar so that the cannon brick can be laid with a complete shield and the passage of efflorescence from common to face brick is absolutely prevented. Mortar so prepared segregates any individual brick which may effloresce. The waterproofing is a prepared oil which (1) waterproofs, (2) thwarts the diffusion of efflorescence, and (3) prevents the mortar from shrinking from the brick. About $4^1/_2$ gal. of oil are used per cubic yard of mortar. New structures which show efflorescence may be treated by mixing a chemically prepared white oil with water or muriatic acid and applying in the regular cleaning-down operation. The method is about 85% effective. Colorless damp-proofing is used for older buildings which show efflorescence. R.G.M.

Prevention of wet walls. L. A. PALMER. *Arch. Forum* [Part II], **56** [1], 103–105 (1932).—The majority of brick walls do not transmit moisture into the interior, but under certain conditions there have been instances of damp interiors in brickwork. There have been numerous "cure-alls" on the market for wet walls. Durability tests consisted of wetting, freezing, thawing, and drying a number of test units composed of brick and mortar. Prior to the durability tests, these units were stored for 2 months under 3 conditions. A duplicate number of units remained in storage for 6 months and then they, together with the units which survived the durability tests, were tested for strength of bond in tension. The conclusions are presented. With mortar in contact with brick, the continuity of pores or voids in the two materials is to some extent broken. Water travels more slowly through assemblages of these materials than through either one separately. Consequently, the rate of transmission of water through solid brick masonry (no openings or cracks) cannot be predicted on the basis of known

rate of absorption of the separate materials. There may be open spaces of another kind in a wall such as those obtained with hollow units or a hollow wall, etc. There must not be any lack of adhesion between mortar and masonry units if the interior wall is to remain dry. See also *Ceram. Abs.*, **11** [2], 106 (1932). E.P.R.

Production of porosity in brick. HANS HIRSCH. *Brit. Clayworker*, **40** [477], 360 (1932).—H. made a series of experiments on changing the porosity of brick by the use of lignite and sawdust. Seven combinations were used which were fired at three temperatures, *viz.*, 900, 1000, and 1080°C. A table shows the linear shrinkage, volume weight, apparent porosity, total porosity, crushing strength, and heat conductivity. R.A.H.

Brick from fly ash. H. C. PEFFER. *Power Plant Eng.*, **35** [24], 1218 (1931).—Results of long investigation as to possibilities of utilizing fly ash were recently presented to the Prime Movers Committee of the N.E.L.A. at its Purdue University meeting. The brick and tile shown have been given the name "Ross-stone." It is produced by a chemical reaction in a process requiring no firing and by the use of ordinary press brick machinery. The process requires 48 hr., and the brick are of uniform texture with a smooth surface. Weight is $4^1/_2$ lb. for the common size of building brick, crushing strength 10,000 lb. Water absorption is 9% with no effect on strength. Mortar adhesion is good and breakage by chipping is about the same as for ordinary brick. As with tile, a pleasing surface is presented with sharp corners and square edges, any color darker than that of fly ash being obtainable by admixture of mineral pigments. It is possible to color to any desired depth from the surface, thus effecting a saving in the expense of coloring. Tile with a polished surface, exposed to weather for a year, showed no signs of deterioration of body or surface. E.P.R.

Reinforced brick ceilings. W. STOY. *Tonind.-Ztg.*, **56** [2], 21–22 (1932).—A new reinforced brick ceiling is described using large hollow tile of the "System Mohring" type. Illustrated. W.M.C.

Efficiency of hollow brick production. ANON. *Tonind.-Ztg.*, **56** [4], 48 (1932).—A discussion is given by several authors of the paper by Hertrampf (see *Ceram. Abs.*, **11** [1], 31 (1932)). W.M.C.

Modern pressed brick manufacture. H. G. BROWN. *Mech. World*, **90** [2345], 576 (1931).—B. details modern methods of manufacture and the making of brick is described. E.P.R.

Fundamentals and economies in the clay industries. XII. ELLIS LOVEJOY. *Clay-Worker*, **97** [1], 22–24 (1932).—The preliminary treatment given clays prior to the final preparation of the clay mixes is discussed. Weathering of clays results in physical and chemical changes. Physically they slake down and soften and the inherent plasticity is made available. A number of minerals in the clay undergo chemical changes. Pyrite dissociates and the sulphuric acid developed dissolves and dissociates other minerals. Gypsum and other soluble salts are formed. Other chemical changes are listed, as are observations of actual cases studied. As storage in the preliminary treatment of clays where they are locally mined is an important factor in the final preparation and in economy, various kinds of storage are discussed. For Part XI see *Ceram. Abs.*, **11** [3], 200 (1932). E.J.V.

Low-density tile. LAURITZ ANDERSSON. *Tegel*, **19** [2], 11–15 (1929).—By the introduction of combustible materials (coke, peat, or wood shavings) in amounts varying from 15 to 80% by volume in conjunction with various Swedish clays, products ranging in bulk density from 0.71 to 1.77 were obtained. Determinations of porosity, absorption, and freezing resistance were made. The compressive strength was found to satisfy the empirical formula: $C = 1000\,(g/s)^3$, where C = compressive strength in kg./sq. cm., g = bulk density, and s = true specific gravity. H.F.V.

Tile and/or concrete as fire protection. LAURITZ ANDERSSON. *Tegel*, **19** [7], 49–52 (1929).—As the result of a disastrous fire in Stockholm, considerable discussion arose as to the relative merits of tile and reinforced concrete as fireproof materials of construction. The Swedish Association for Fire Protection called a meeting of representatives of building associations, testing laboratories, various technical societies, and others to discuss the matter. A. outlines the arguments of those who consider concrete more desirable, and then gives his own ideas which are favorable to tile. (A. is director of the Swedish Tile Industries Association.) He concludes, however, that for fireproof construction the use of tile with concrete would be preferable to the use of either alone. H.F.V.

Westmold face brick, a new achievement in brickmaking. ANON. *Bldg. Supply News*, **42** [2], 93 (1932).—A true sand-molded brick tempered softer than usual and made of subsurface shales and fire clays is textured on five sides so that it may be laid on edge as well as flat. No two brick are alike and none is mechanically precise in shape. E.C.C.

Common brick for facing purposes. SOUTHERN BRICK & TILE CO. *Brick Clay Rec.*, **80** [1], 30–31 (1932).—A quality sand-molded brick is being sold for facing purposes at face-brick prices. A description of the plant is given. Illustrated. E.J.V.

Common brick in Chicago. ANON. *Brick Clay Rec.*, **80** [1], 18 (1932).—A remarkable activity is being shown in reinforced brickwork in this territory. Illustrated. E.J.V.

West Brothers Brick Company's plant. ANON. *Clay-Worker*, **97** [1], 16–19 (1932).—A detailed description of the plant, equipment, and operation is given. Illustrated. E.J.V.

Mason City spends $450,000 remodeling its plants. ANON. *Brick Clay Rec.*, **80** [1], 35–40 (1932).—The changes in plant equipment made in the modernization are described. Illustrated. E.J.V.

A one-man brick factory. ANON. *Clay-Worker*, **97** [1], 24–25 (1932).—James Foust, Madison, N. C., negro now in his 102nd year, is the owner, manager, superintendent, and employee of a brick plant. His methods and equipment are described. Illustrated. E.J.V.

Resurfacing worn concrete pavements with vitrified paving brick. ANON. *Clay-Worker*, **97** [1], 32–34 (1932).—The Illinois State Highway Department is beginning highway economy by salvaging 64 miles of concrete pavements with a resurfacing of vitrified paving brick. The locations are given and a description of the design of the resurfacing is presented. Illustrated. E.J.V.

New products and new markets in the clay industry. ANON. *Brick Clay Rec.*, **80** [1], 25–28 (1932).—Reinforced brickwork, light-weight units, glazed products, and new textures and colors presage the best years in the history of the industry. Each of the individual products is discussed. Illustrated. E.J.V.

Clay tile markets. J. J. CERMAK. *Brick Clay Rec.*, **80** [1], 34 (1932).—Stressing the markets for floors, partitions, and fireproofing, the structural clay tile industry is laying plans for the future. Illustrated. E.J.V.

PATENTS

Process of manufacturing light-weight aggregates and structural blocks formed thereof. EMMETT V. POSTON. U. S. 1,842,048, Jan. 19, 1932.

Process of producing light-weight building materials. ROBERT K. MCBERTY. U. S. 1,842,186, Jan. 19, 1932.

Brick-laying machine. WILLIAM H. MASSEN. U. S. 1,843,092, Jan. 26, 1932.

Refractories

Methods for the evaluation of refractories. I. Chemical analysis. L. BELLADEN AND C. F. BECCHI. *Met. ital.*, **22**, 870–77 (1930); *Ann. chim. applicata*, **21**, 307–23 (1931); *Refrac. Jour.*, **7** [11], 508 (1931).—The methods of analysis for refractories have not been satisfactorily standardized. (1) SiO_2: Two evaporations and subsequent filtrations are necessary, but the intermediate ignition to 110° or 150° is of no help. Either water or HCl is satisfactory in washing the precipitate, but the use of $HClO_4$ causes loss of SiO_2. (2) Al_2O_3: NH_4 salts in moderate excess do not interfere in Al_2O_3 determinations. The Al_2O_3 is washed with neutral NH_4NO_3 solution. Large amounts of alkali salts do not interfere. The solution should not be boiled after precipitation as this makes the subsequent filtration more difficult. The method of Wöhler, Chancel, and Carnot gives excellent results; the precipitate filters rapidly, but ignition of the precipitate must be prolonged. (3) Fe_2O_3: The best gravimetric determination consists in converting to FeS and then roasting this to Fe_2O_3. The Zimmermann-Reinhardt is the best volumetric method. (4) TiO_2: The colorimetric method is preferred. (5) CaO and MgO: When present in small amounts, as is usually the case, precipitation with $(CO_2H)_2$ in the presence of either methyl orange or phenol blue is satisfactory, no MgO being occluded. (6) Alkalis: The method of J. Lawrence Smith is recommended. With the above methods, a rapid method for the analysis of refractories is outlined. (*C.A.*)

Electrical resistivity of refractory materials at elevated temperatures. H. M. KRANER. *Ind. Eng. Chem.*, **23** [10], 1098–1102 (1931).—The effect of impurities, particularly upon the electrical conductivity of ceramic material at elevated temperatures, is treated. Generally speaking, the electrical conductivity of a ceramic mass depends on its ionic mobility, viscosity, etc. The term "impurity," as used, is not limited to those materials which occur naturally with the principal constituent under consideration, but is used also to apply to materials intentionally added to the principal constituents for bonding purposes in the firing process. Ceramic refractory compositions are regarded as similar materials, a glass being the bond in most cases and the various compositions varying in the amount of this bond. The glass bond usually contains the larger number of the components present, and therefore its composition to a large degree determines the electrical character of the ceramic body. A review of the electrical characteristics of various glasses at elevated temperatures and the works of several well-known authors are discussed to illustrate the generalizations made. R.G.M.

Testing refractories. W. C. KERNAHAN. *Refrac. Jour.*, **7** [12], 556 (1931); for abstract see *Ceram. Abs.*, **10** [8], 575 (1931). E.P.R.

Refractory blocks in glassmaking. MAURICE SCOHY. *Rev. belge ind. verrières*, **2**, 122–25 (1931).—S. discusses the attack of refractories by molten glass. The proper tests to be made on refractories are tabulated. A table gives the results of experimental work performed by S. and compares loss of weight, porosity, and per cent alumina of various refractories when subjected to attack by sodium carbonate. S. concludes that (1) the alumina content of the refractory should be as high as possible and never below 30%, the upper limit being fixed by the necessity of using bauxite, which is unsatisfactory because of the high iron content; (2) the porosity should be as low as possible. This is obtained by careful choice of grain sizes, proper type of grog, the least possible amount of mixing water, and long firing at high temperatures. A.J.M.

Refractories for glass tanks. H. SCHILLING. *Refrac. Jour.*, **7** [12], 556 (1931); for abstract see *Ceram. Abs.*, **10** [12], 834 (1931). E.P.R.

Special refractories. H. E. WHITE. *Refrac. Jour.*, **7** [12], 556 (1931); for abstract see *Ceram. Abs.*, **11** [3], 180 (1932). E.P.R.

Super-refractory. LACLEDE-CHRISTY CLAY PRODUCTS CO. *Blast Fur. Steel Plant*, **20** [2], 197 (1932); for abstract see *Ceram. Abs.*, **10** [10], 707 (1931). E.J.V.

Protective coatings for refractories. ANON. *Chem. Trade Jour.*, **90** [2328], 8–9 (1932).—The author describes the work of L. Litinsky (*Ceram. Abs.*, **10** [9], 645 (1931)) on this question and discusses (1) the choice of grouts and washes, (2) linings for furnaces, (3) glazes for gas retorts, (4) some silicon carbide products, (5) bauxite and chromite washes, and (6) general conditions governing selection. M.V.K.

Corrosion of refractories. J. F. HYSLOP AND H. C. BIGGS. *Brit. Clayworker*, **40** [477], 335–36 (1931); for abstract see *Ceram. Abs.*, **11** [3], 181 (1932). R.A.H.

Refractory materials produced by melting. F. REINHART. *Tonind.-Ztg.*, **56** [3], 32–34 (1932).—Different patents are reviewed which deal with the possibility of producing refractory materials by melting. The installations make use of the electric arc, the heat of reaction during the firing of aluminum, the heat generated by an electric current when passing through a resistance, high-frequency furnace, etc. The molten material may be poured into forms or may be used as a high-temperature lining of kilns. W.M.C.

Silicon carbide refractories. W. RUPPMANN. *Refrac. Jour.*, **7** [12], 556 (1931); for abstract see *Ceram. Abs.*, **10** [4], 273 (1931). E.P.R.

Examination of tank blocks by the hydrofluoric acid method. ANON. *Rev. belge ind. verrières*, **2**, 223 (1931).—The method of Bowmaker and Partridge is described. Comparative results are given. See also *Ceram. Abs.*, **11** [2], 115 (1932). A.J.M.

History of silica brick. THOMAS N. KURTZ. *Bull. Amer. Ceram. Soc.*, **11** [2], 26–33 (1932).—The first authentic record of the manufacture of silica brick in the U. S. is that of A. J. Haws & Son, Johnstown, Pa., in 1883. The four groups of sizes and shapes of silica brick manufactured are discussed. The standardization and simplification of sizes was begun in 1912 and has resulted in great benefits to the consumer and producer. The early methods of manufacture are discussed and compared with the present carefully controlled manufacturing processes. E.J.V.

Dinas silica fire brick. R. RICHARDS. *Western Mail & South Wales News Eng. Supp.; Refrac. Jour.*, **7** [12], 516 (1931).—Over a century ago Weston Young invented the Dinas silica fire brick. The name "Dinas" is derived from Graigy Dinas, in the Neath Valley, where are situated the original quarries from which Y. obtained the raw material. He introduced Dinas silica brick into the Sheffield district in the early sixties and since then their manufacture has developed into an extensive industry. The products include brick and shapes for the steel, tin-plate, and copper industries, and linings for marine boilers of liners and warships burning oil fuel, etc., in the manufacture of which the Risca Works occupy a leading position for quality. The raw material used at Risca is a high-grade fire clay with a fusion temperature of 1650 to 1700°C and ranks with any produced in Great Britain. Recently this company has been manufacturing under a German license a "checker" brick for steel furnaces. The special feature of this brick is that because of its peculiar shape it has the effect of retaining in the "checker" a higher proportion of waste heat coming from the furnace than standard brick. The furnace efficiency is thereby improved resulting in larger output and reduced fuel consumption. E.P.R.

Manufacture of silica brick from Russian quartzites. M. G. STEPANENKO, P. I. GALKIN, AND A. A. KORCHAGIN. *Glastech. Ber.*, **9** [1], 54 (1931); for abstract see *Ceram. Abs.*, **10** [6], 437 (1931). M.V.K.

Ceramic masses from pure magnesium oxide. BICHOWSKY. *Sprechsaal*, **64** [53], 994 (1931).—Magnesium oxide is used in kiln constructions, laboratory utensils, and as electric insulating material. It is used in the first two fields because of its high fusing temperature (2800°C; at about 2000° it begins to volatilize) and its high capa-

bility of resisting a chemical attack. The coefficient of expansion of magnesium oxide is 13.0×10^{-6} (20 to 600°) but densely sintered MgO is sensitive to temperature changes. The main requirements of an electric insulating material are (1) specific electric resistance at high temperature and (2) thermal conductivity. MgO has a higher insulating capability than kaolin, sillimanite, and silica brick between 800° and 1200°. There are two possibilities of using magnesium oxide for insulation: (1) in the form of poured or stamped masses with which intermediate or hollow spaces are filled up and (2) in the form of ceramic shaped separate objects. For the second case, magnesium oxide must be present as a sufficiently plastic mass. Magnesium oxide alone is only slightly plastic (Ruff). It can be made plastic by (1) mixing weakly and thoroughly firing, (2) adding hydroxides, (3) adding organic setting agents such as tar and bitumen, (4) treating with acids and bases, (5) adding electrolytes, and fine grinding, and (6) adding $MgCl_2$. By combining suitable methods, it was possible to prepare masses which could be drawn into pipes and pressed into complicated shapes. A special firing technique was used because of the peculiarities of the mass. It is not necessary to fire magnesium oxide objects thoroughly for insulating purposes. The sintering lasts till sufficient strength is obtained (equal to a good grog). The porosity of the objects varies between 0 and 20 according to the use. Periclase crystals are clearly seen in the thin sections. The analysis of the finished product is 99.2% MgO, 0.4% Al_2O_3 + Fe_2O_3, and 0.4% SiO_2. The impurities come from the raw materials. The specific insulating resistance in ohm cm. is given in a table. The curve of the insulating resistance lies higher than that of the best insulating ceramic materials with the distance, and the conductivity follows the law $K = 3.6e^{-17850/T}$. The curve of the voltage of a current of a magnesium oxide mass shows no variations which intimate phenomena of polarization. The conductivity is probably electronic. The thermal conductivity was not measured although tests showed that it is much higher than that of porous or dense ceramic materials. M.V.K.

Research on magnesia refractory products. LONGCHAMBON AND KO-FUH-TSIANG. *Rev. mat. constr. trav. pub.*, No. 265, p. 186*B* (1931); *Refrac. Jour.*, **7** [12], 556 (1931); for abstract see *Ceram. Abs.*, **11** [2], 113 (1932).

New developments in unfired magnesite brick for the metallurgical industry. A. E. FITZGERALD. *Mining & Met.*, **12** [300], 527–32 (1931).—Magnesite brick production requires special methods which ordinarily include two firings. Early unfired magnesite brick showed two defects: (1) the brick shrank, and (2) sintering did not extend to brickwork which attained only intermediate temperatures. To overcome this shrinkage problem (1) the forming pressure was increased from 1000 to 10,000 lb./sq. in.; (2) interfitting of the grains was developed to a maximum by gradation of particle sizes; and (3) a colloidal coating was used as a lubricant between the particles. The unfired brick showed greater cold crushing strength, lower rattler loss, lower shrinkage at 2700°F, and superiority in load tests. The unfired brick had a marked resistance to spalling, no loss being suffered in 20 cycles at 1000°C. The unfired brick also had less permeability to gases under pressure. Some industrial applications of these brick are discussed in detail. Illustrated. E.J.V.

X-ray investigations on magnesite blocks. OTTO KRAUSE AND WALTER KSINSIK. *Feuerfest*, **7** [12], 177–79 (1931).—The appearance of magnesia ferrite in magnesite blocks was detected exactly for the first time. M.V.K.

Refractory materials with a talc and magnesia base. P. N. SHABLUIKIN AND V. N. ANDREEV. *Mineral. Suir'e*, **6** [1], 39–46 (1931); *Chim. & ind.*, **26** [6], 1395 (1931).—Owing to the fact that natural talc rocks are not sufficiently refractory because of their heterogeneous composition, tests were made with powdered talc stone and magnesia in quantities corresponding to the composition of forsterite ($2MgO \cdot SiO_2$) whose fusing

point is 1800°. Talc rock from Syrostan was used as a raw material and contained 48% talc, 48% carbonates, and 0.3% chlorites. Tests showed that in samples composed of 70% talc stone and 30% MgO and fired to 1500°, the resistance to pressure begins to decrease at 1460°, and that artificial brick made of these materials are more durable and less corroded than natural talc blocks. M.V.K.

Study of refractory properties of rocks containing talc. N. V. ANDREEV. *Mineral. Suir'e*, **6** [1], 33–38 (1931); *Chim. & ind.*, **26** [6], 1396 (1931).—Talc stones were used for the foundation of metallurgical kilns in the Ural Mountains owing to their refractoriness and resistance to the attack of iron oxide. The lifetime of these brick seems to be 30% longer than that of grog. Talc brick of Syrostan-Shabrovo are a mixture of talc, carbonates of iron, magnesite, and chlorite. The curves of the resistance to pressure of raw and calcined brick show that this resistance begins to decrease rapidly at 1400° in raw brick; in brick calcined at 800°, at 1420°; and in those calcined at 1000°, at 1440°. The resistance to pressure of a raw talc brick is from 104 to 161 kg.; that of a brick calcined to 800°, 181 to 287 kg.; and that of a brick calcined to 1000°, 529 kg. M.V.K.

Application of refractories to boiler furnaces. JOHN WALKER. *Eng. Boiler House Rev.*, **45** [4], 250–51 (1931); *Sprechsaal*, **64** [52], 976 (1931).—Grog brick are the most suitable refractories for boiler furnaces. Tests with highly refractory materials such as sillimanite, fused alumina, and silicon carbide yielded varying results. The unsatisfactory results with refractory materials are due mainly to (1) the unsuitable constructions of furnaces and (2) a rather arbitrary use of refractories without taking into consideration the conditions in which they are to be used. It is easy to obtain a sufficient resistance to the heat only. The failure of the material is caused in many cases by corrosion, softening, and possibly erosion of the brick by ashes or slag. These difficulties rapidly increase with the firing temperature because of the active nature of slag. In the simplest construction, the interior wall is made of good grog brick separated by an intermediate space of 15 to 22 cm. from the insulated outside wall. The air between the walls cools the interior wall and then is used for firing. The use of highly refractory materials may be unsatisfactory because refractoriness alone is insufficient. Other important factors are the chemical nature of the material and that of the slag. *E.g.*, magnesite blocks are unsuitable for boiler furnaces because they are attacked by strongly acid slag even at mild temperatures, although magnesia has its fusing point at 2800°. Silicon carbide is distinguished by its refractoriness, inertness to slag attack, and a high thermal conductivity. Several patented air- or water-cooled wall constructions of silicon carbide blocks are described. M.V.K.

Study of refractories service conditions in boiler furnaces. RALPH A. SHERMAN. *Fuel Sci. Practice*, **10** [9], 400–19; [10], 445–58; [11], 488–500; [12], 531–38 (1931); **11** [1], 28–35 (1932); for abstract see *Ceram. Abs.*, **10** [6], 438 (1931). R.G.M.

Furnace walls. VII. GEORGE P. REINTJES. *Blast Fur. Steel Plant*, **20** [2], 204–206 (1932).—The arch is one of the earliest inventions of man. It was discovered that an arch built with the joints between the arch stones radiating toward a common center would be more substantial as the tapered stones or tile would tighten as the arch endeavored to settle. In 1847 a round arch that would not collapse due to external or internal pressures was patented by Preston. Later, a serpentine shaped arch brick was developed. Vrooman's patent, issued in May, 1899, consisted of a series of offset tile that would tend to prevent the brick from falling out when subjected to heat, as was the case when ordinary brick were used to form the arch. In R.'s original design of an arch he used a split key to take care of the after-shrinkage of the tile so as not to place an undue tension on the lugs. In the next development the play between the companion lugs was increased so that each tile could open at its joints as the arch rose

from expansion and lowered from contraction. In taking care of end thrust it was discovered that if the arch end tile were supported below the center, preferably in the lower one-third or lower one-fourth, an arch forming a three-point suspension was obtained instead of a four-point suspension as is the case where a solid skewback support is used. Illustrated. For Parts V and VI see *Ceram. Abs.*, **11** [3], 184 (1932).

E.J.V.

A rapid method of estimation of alumina in clays. R. W. ELLISON. *Jour. Amer. Ceram. Soc.*, **15** [3], 188–90 (1932).

Sillimanite cement. CHAS. TAYLOR SONS CO. *Blast Fur. Steel Plant*, **20** [2], 204 (1932).—The properties of P. B. Sillimanite for furnace construction and repairs are as follows: (1) The refractoriness is about 200°F higher than the best grades of fireclay or silica brick. (2) The bonding strength is ample for all purposes over a complete range of furnace temperatures. (3) The shrinkage is so low there is no evidence of cracking or peeling in use. (4) The troweling properties are excellent and there is no tendency to settle when made up with water to a dipping consistency. (5) The resistance to slagging is much greater than with cements having a fireclay base. See also *Ceram. Abs.*, **9** [10], 849 (1930). E.J.V.

Degree of fineness of particles. ANON. *Blast Fur. Steel Plant*, **20** [2], 204 (1932).—In present-day manufacture of refractory materials, it is important that careful control be maintained over the degree of grinding and the proportion of particle sizes to assure uniformity in the properties of the brick and close adherence to size. It is also advisable to take into consideration the particle size of the constituents used in the development of new or special bodies, mortars, and high-temperature cements.

E.J.V.

Uniformity of grain size in fire brick. A. D. COCHRAN. *Brick Clay Rec.*, **80** [1], 41–45 (1932).—The New Florence Fire Brick Co., New Florence, Mo., has improved product quality through more uniform grain sizing and uniform sizing of the ware. The methods of manufacture are discussed. Illustrated. E.J.V.

British Refractories Research Assn. ANON. *Brit. Clayworker*, **40** [477], 364–66 (1932).—A brief outline of each of the following problems which are being studied is given: (1) drying problems, (2) the plastic properties of clays, (3) ovens and kilns, (4) the permeability of refractory materials to gases, (5) the action of carbon monoxide on refractory materials, (6) jointing cements, (7) investigations for the gas industry, (8) blast-furnace investigations, (9) the sagger problem, (10) the development of special refractory materials, (11) silica inversions, (12) highly grogged fire brick, (13) channel brick, runners, etc., and (14) the corrosion of refractory materials by slags, glasses, and frits. R.A.H.

BOOKS AND CATALOGUES

Refractories. MCLEOD & HENRY CO. *Abrasive Ind.*, **13** [2], 31 (1932).—Catalogue No. 232 describes various types of refractory blocks, brick, and complete settings of silicon carbide refractories. Physical characteristics and manufacturing processes are given in detail together with the advantages, limitations, and high-temperature applications in lining boilers, industrial furnaces, kilns, retorts, and muffles. See also *Ceram. Abs.*, **11** [2], 116 (1932). E.P.R.

High Alumina Blocks for Lining Rotary Cement Kilns. ANON. Published by Algernon Lewin Curtis, Westmoor Laboratory, Chatteris. 24 pp. *Refrac. Jour.*, **7** [8], 389 (1931); *Zement*, **20** [36], 825 (1931).

Refractories. F. H. NORTON. Reviewed in *Refrac. Jour.*, **8** [1], 32 (1932); for abstract see *Ceram. Abs.*, **11** [1], 40 (1932). E.P.R.

Book Review

Refractory Materials. I. F. PONOMAREV. Vtuz. ed. Tomsk, 1931. 182 pp. 5R. This book is a compilation of lectures read in different universities in Russia. The book treats of the following subjects: (1) characteristics of refractories; (2) their classification (acid, neutral, and basic), refractories of different composition, and those containing carbon; (3) systems which are related to refractories, systems of silicates; (4) Dinas, its characteristics, preparations, and use; (5) grog objects, fire clay and its properties, and manufacture of grog; (6) highly refractory materials; (7) refractories containing carbon; (8) properties and testing of refractories: physical and chemical properties, microstructure, technical properties; (9) uses of refractories; (10) care of refractories. M.V.KONDOIDY

PATENTS

Dense refractories. C. A. JENSEN. Brit. 364,131, Jan. 13, 1932.

Refractory brick. GUSTAVE ZIERER. Fr. 705,721, Sept. 3, 1930. Refractory and other brick which do not require baking are made with sands or earths, refractory or not, a Mg salt ($MgSO_4$, $MgCl_2$, etc.), a soluble silicate, and water. (*C.A.*)

Alumina. I. G. FARBENIND. A.-G. (Heinrich Specketer, inventor.) Ger. 525,067, Nov. 5, 1925. Crude aluminous materials such as clay are dissolved as far as possible in an acid, the insoluble SiO_2 is filtered, and the filtrate is evaporated and calcined so as to convert the Al and Fe salts into the oxides. The oxide mixture is heated with C in an electric furnace until the Fe_2O_3 is reduced, and the mixture is then separated. See following abstract. (*C.A.*)

Alumina. I. G. FARBENIND. A.-G. Ger. 533,108, Aug. 25, 1926. The method of Ger. 525,067 for the manufacture of Al_2O_3 from clay, etc., is extended to the treatment of bauxite, leucite, and like aluminous materials which are attacked by acids. (*C.A.*)

Terra Cotta

The "moisture expansion" of glasses. LOWELL H. MILLIGAN AND DAVID ARMITAGE. *Jour. Amer. Ceram. Soc.*, **15** [3], 167–70 (1932).

Testing method for weather-stable glazes. H. EISENLOHR AND HEINZ DIEHL. *Sprechsaal*, **65** [3], 42–43 (1932).—The standard grit testing method of the German Glass Technical Society used on glaze frits showed that (1) the general opinion that glazes free from lead are more weather stable than glazes containing lead was proved false. It was found that the "grit solubility" of ordinary glazes containing lead is smaller than that of glazes free from lead with a similar firing temperature, for in order to keep low the melting point of glazes free from lead, other fluxes which influence the solubility unfavorably, boric acid especially, were used instead of lead. (2) The silica content is not a measure for the weather stability of glazes. Glazes containing 2.5, 3.0, and 3.5 mol. silica showed an average solubility figure of 265 mg.; they are the most sensitive of all the glazes investigated. The melting point of glazes increases proportionally to the silica content. (3) The cone melting point of glaze frits can be within the limits of 700 to 900° without influencing the "grit solubility." For the cone melting point of 710°, the "grit solubility" was found to be 96.4 mg., and for the cone melting point of 860°, it was 286 mg. (4) A decrease of the boric acid content may improve the "grit solubility" in glazes free from lead. (5) Besides Na_2O and K_2O, the correct choice of other bases, *e.g.*, zinc oxide, baryta, calcium oxide, and lead oxide is of the greatest importance for the decrease of the "grit solubility." M.V.K.

Observation on crazing in terra cotta glazes. C. W. PLANJE. *Pottery Gaz.*, **57** [656], 231–32 (1932); see *Ceram. Abs.*, **10** [11], 785 (1931). E.J.V.

Gas-firing terra cotta for efficiency. J. B. NEALEY. *Ceram. Age*, **18** [2], 78–120 (1931).—The Denver plant of the Northwestern Terra Cotta Co. is described. Firing is accomplished in five kilns ranging in capacity from 4 to 60 tons each, heated with gas burners of the atmospheric type, having been converted from a system of coal firing. The kilns are of standard muffle type and the burners are cemented directly into the fire boxes. Both up- and down-draft kilns are represented. Gas is furnished at 5-lb. pressure and air is inspirated in the correct proportion at the burner. The maximum firing temperature is 2200°F and the firing time ranges from 72 to 110 hr. according to conditions. R.G.M.

Refractory material in architectural design. ANON. *Refrac. Jour.*, **7** [12], 515 (1931).—A joint meeting of the Refractories Assn. of Great Britain with the Sheffield Clay Working Trades Technical Society was held at the University, Sheffield, when a brief paper was read by J. E. Benn, Jr., of the Leeds Fireclay Co., Ltd., Wortley, Leeds, on "Refractory Materials in Architectural Design." The lecture was illustrated with lantern slides showing the manufacture of fireclay goods and the glazing of ware for exterior decoration was also dealt with. E.P.R.

Tradition and modern building constructions. W. LUDOWICI. *Tonind.-Ztg.*, **55** [82], 1145–47; [83], 1162–63; [88], 1226–28; [89], 1236 (1931).—The principles of modern and ancient building constructions are compared. Illustrated. W.M.C.

Decorative arts in ancient Corinth. H. PAYNE. *Illus. London News*, **179**, 850–54 (1931).—Terra cottas, etc., from the temple of Hera excavated by the British School in 1931 are illustrated. See also *Ceram. Abs.*, **10** [1], 14 (1931). H.H.S.

White Wares

Microscopic examination of ceramic raw material and fired products, a help in plant control. IRMA RHODE AND HERMANN HARKORT. *Jour. Amer. Ceram. Soc.*, **15** [3], 179–87 (1932).

Some notes on the nature of clay. F. H. NORTON AND F. B. HODGDON. *Jour. Amer. Ceram. Soc.*, **15** [3], 191–205 (1932).

Color formation in vitreous bodies. F. H. NORTON AND V. I. DUPLIN, JR. *Jour. Amer. Ceram. Soc.*, **15** [3], 206–12 (1932).

Ceramic materials in high-tension technique. M. RECK. *Sprechsaal*, **65** [2], 25–26 (1932).—Porcelain answers all mechanical and electrical requirements. Its defects are high shrinkage, long and elaborate working processes, and difficulties of firing large pieces. Steatite has a high tensile strength and is a good material for motor insulation although its electrical properties are lower than those of porcelain. Melalithe has almost the same properties as porcelain. It is more easily worked up than porcelain and can be used for large objects. Sillimanite is easily worked because of its plasticity and its coefficient of shrinkage is small. Data on the electrical properties of these materials are given. M.V.K.

Mining and treatment of the sillimanite group of minerals and their use in ceramic products. FRANK H. RIDDLE. *Mining & Met.*, **13** [302], 10 (1932).—Minor occurrences of natural minerals of the so-called "sillimanite type" and dumortierite have been known for years. Commercial deposits were not found or developed until after 1920. It was found that the proper addition of synthetic sillimanite produced outstanding properties in ceramic products. Regardless of the proportions in which the two oxides SiO_2 and Al_2O_3 occur after exposure to furnace temperatures, mullite is formed with one

or the other oxide in excess, the amount depending on the original amount present. Many experiments have shown that both the natural minerals and synthetic substitutes may make a desirable, active super-refractory. Over 350 million spark-plug cores have been made from andalusite and dumortierite. Important localities of the minerals are briefly described. E.J.V.

Presence of calcium sulphate in clays and its influence on casting. A. CASTIGLIONI. *Sprechsaal*, **64** [52], 976 (1931); for abstract see *Ceram. Abs.*, **10** [10], 732 (1931) M.V.K.

Using tension measurements of warping in ceramic products. W. STEGER. *Sprechsaal*, **64** [53], 994 (1931); for abstract see *Ceram. Abs.*, **10** [3], 206 (1931). M.V.K.

Comparative study of ball clays in semiporcelain bodies. ANON. O. S. U. Eng. Expt. Sta., *News Bull.; Ceram. Ind.*, **18** [1], 27 (1932); see also *Ceram. Abs.*, **10** [10], 714 (1931). W.W.M.

New method of laying tile. MORTENSON ENGINEERING CO. *Ceram. Ind.*, **18** [2], 97 (1932).—The trade name of "Snapon" has been applied to a type of metal lath having metal fingers which have been punched out in such a way as to grip the tile and hold it in place. Cost of tiling is reduced by this method. It can be put on over paper or plaster and the home owner can set his own tile. The tile are held more rigidly than when simply pasted on the wall. W.W.M.

Glazed clay in a modern dairy. ANON. *Ceram. Age*, **18** [2], 75–77 (1931).—The dairy is described and illustrated. R.G.M.

Range of production of English pottery. ANON. *Times Eng. Supp.*, **29**, 179 (1931).—The pottery industry in England is much more comprehensive in its output than it was two years ago. Production ranges from every phase of low-priced domestic ware and cheap tea ware to tile and attractive ornamentals. H.H.S.

BULLETIN

The substitution of lead glazes by leadless. V. V. SAGALATOV. *Trans. Kiev Div. Ukrainian Sci. Research Inst. Silicate Ind.* [U.S.S.R.], **7**, 95 pp. (1930).—In the first part a general description is given of glazes, the adjusting of glazes to bodies, thermal coefficients of expansion, lead poisoning, and the composition of leadless glazes. The second part treats of S.'s experiments to cover earthenware of the composition 35.12-SiO_2, 8.20Al_2O_3, 0.13CaO, and 0.87K_2O with leadless glazes and their mixtures recommended by Seger, Eisenlohr, Sokolov, Orlov, Hanna, Ponomarev, etc. The third part deals with the rôle of anions in leadless glazes and discusses briefly the defects of these glazes. Conclusions are as follows: (1) From the 130 tested leadless glazes only 33 were good. (2) The three best glazes had the following compositions (after Seger's formula):

SiO_2	B_2O_3	Al_2O_3	K_2O	Na_2O	CaO	MgO	BaO
3.33	0.74	0.43	0.29	0.37	0.33		
3.40	0.90	0.59	0.09	0.45	0.40		0.05
3.75	0.56	0.44	0.28	0.28	0.44		

(3) A leadless glaze may be obtained satisfying all requirements in relation to the quality and price even on a body rich in alumina as in the present experiment. (4) To obtain leadless glazes with a good flow it is necessary to take 0.6 molecule of alkalis; the quantity of K_2O should be the least as it gives viscous glasses. (5) To avoid matting and bubbles the fritting of all components should be carried out carefully. (6) To obtain glazes with a good brilliancy it is necessary to smear the sagger with the frit rich in alkalis and B_2O_3. The appendix contains the compositions of the 130 tested glazes. S.I.P.

PATENTS

Tile exhibitor. WILLIAM MCCOY. U. S. 1,841,620, Jan. 19, 1932.

Tile setter. ARMIN L. SCHREIBER. U. S. 1,841,641, Jan. 19, 1932.

Method of and apparatus for producing pottery ware. W. J. MILLER. Brit. 364,181, Jan. 13, 1932.

Machine for brushing fired earthenware and china. L. HORNE AND R. HORNE. Brit. 364,242, Jan. 13, 1932.

Equipment and Apparatus

Stokers and pulverized fuel equipment. ANON. *Power Plant Eng.*, **36** [2], 64–67 (1932).—The American Engineering Co. announces the introduction of a compact 5-h.p. electrohydraulic transmission which will develop full rated torque at any speed from 1 to 1000 r.p.m. Since torque is constant, the horsepower output varies with the speed of the hydraulic motor, developing 5 h.p. at maximum speed. The Combustion Engineering Corp. has recently developed the C-E electric stoker drive now available for type E and type K stokers and applicable wherever steam pressure is insufficient for the standard steam drive. The Raymond roller mill, formerly used entirely with the storage system of pulverized fuel, has been successfully used with direct-fired systems. One such installation operating satisfactorily under extremely variable load on all units is at the Pittsburgh Steel Co. Emphasis placed on the economical use of pulverized coal by small- and medium-sized industrial boiler plants has resulted in the need of a coal pulverizer that has the same relative performance and reliability demanded of higher capacity pulverizers in the larger stations. To meet these requirements the Fuller-Lehigh Co. has developed and placed on the market a new pulverizer known as the Type C pulverizer. The design of this mill includes the ball and grinding ring principle of pulverizing. In this arrangement coal is pulverized by large-diameter balls grinding under pressure between upper and lower grinding rings. Pressure between the grinding parts is applied and maintained by a heavy steel spring mounted in the top section of the mill. Wet coal can be pulverized in the Type C pulverizer when preheated air is used for separation of the fines. E.P.R.

Coal and ash equipment. AMERICAN ENGINEERING CO. *Power Plant Eng.*, **36** [2], 67–70 (1932).—A new ash hopper consisting of two sections, the upper or storage section and the lower or auxiliary roll section, enables positive, controlled discharge. The Kennedy transport system transports material by pneumatic means alone. For the elimination of all air pollution, the Kennedy fly ash collector has been developed which embodies the principle of the vacuum cleaner and cyclone precipitator. The collector is attached at the last pass of the boiler or close to the base of the stack. E.P.R.

Furnace walls, sootblowers, and baffles. AMERICAN ENGINEERING CO. *Power Plant Eng.*, **36** [2], 62–64 (1932).—Under severe operating conditions and high burning rates, coals with low fusion temperatures and high sulphur or iron content form slag which flows over and adheres to the water walls. To prevent this a "slag drip" construction was developed by introducing one or more bare tubes over the block portion projecting beyond the face of the wall. The slag drips off the ledge in relatively small amounts formed by the bare tubes and falls into the fuel bed to be carried into the ash pit. At a large eastern central station the side walls instead of being straight were flared out at the bottom to permit the installation of a stoker wider than the boiler. This practice makes use of extra floor space and is expected to be followed out to a much greater extent in the future. E.P.R.

Furnace for examination of specimens at high temperatures. B. A. ROGERS.

Metals & Alloys, **2**, 9 (Jan., 1931); *Instrument World*, **4**, 100 (1931).—A new type of furnace fixed to a microscope stage is described and illustrated with 11 photomicrographs and 2 tables. H.H.S.

Flame-proof electrical apparatus. H. RAINFORD AND I. C. F. STATHAM. *Fuel Sci. Practice*, **10** [12], 504–20 (1931).—The design of flame-proof enclosures for electrical apparatus for use in various industries where inflammable gases and vapors are encountered is discussed. R.G.M.

Working machines. PAUL WIESSNER. *Keramos*, **10** [25–26], 663–64 (1931).—The work of edge mills and other machines used for preparing clays is unsatisfactory because they warm up the clay during grinding. This heating destroys plasticity and the colloids of the clay and is due to the quality of the steel used. A new kind of steel called "Keramite steel," doubles the life of the machine. It has a high carbon, silicon, and manganese content and is melted and cast in a special way. M.V.K.

Some experiences with the Dorr mill in grinding quartz and flint for pottery purposes. A. S. W. ODELBERG. *Ber. deut. keram. Ges.*, **12** [8], 401–404 (1931); for abstract see *Ceram. Abs.*, **3** [1], 17–18 (1924) and **4** [12], 349–50 (1925). E.J.V.

Berg dry-press machine. INTERNATIONAL CLAY MACHINERY CO. *Clay-Worker*, **97** [1], 37 (1932).—A new dry-press brick machine capable of pressing hollow brick, producing products up to $4^{5}/_{8}$ in. in thickness, and developing a maximum pressure on the brick of 1800 tons has been developed. Illustrated. E.J.V.

Perforated metal plate instead of wire cloth. VINCENT CLAY PRODUCTS CO. *Brick Clay Rec.*, **80** [1], 45 (1932).—Having had up to 50% tailings, and sticking of moist clay in the wire screen, a change was made to the use of a perforated metal plate having the same mesh areas. The result eliminated sticking and reduced tailings to 15%. Illustrated. E.J.V.

Tunnel driers with moving charges. II. CARL LOESER. *Sprechsaal*, **65** [2], 21–25 (1932).—L. describes the mode of operation and economies obtained when using tunnel driers with moving charges. For Part I see *Ceram. Abs.*, **11** [2], 123 (1932). M.V.K.

Improving hot-floor driers. ANON. *Brit. Clayworker*, **40** [476], 317 (1931).—One of the chief objections to driers consisting of a large shed with a floor heated by fires, hot gases, or steam, is the absence of adequate air movement. The result is that the drying is irregular and slow. These faults are chiefly due to four causes: (1) excessive openings in the walls of the drier, (2) too much overhead space, (3) lack of sufficient ventilation, and (4) insufficient movement of air in the driers. Methods for overcoming these defects are described. R.A.H.

Building costs of artificial drying plants. E. HUETTEMANN. *Tonind.-Ztg.*, **56** [1], 3–5; [2], 18–20 (1932).—The building costs of different types of artificial drying plants are compared as well as the costs of running the drying installations. The products to be dried in the different plants are porous brick, common brick, and roofing tile. Illustrated. W.M.C.

Recent advances in pyrometry. E. GRIFFITHS. *Jour. Inst. Metals* (June and July, 1931); *Instrument World*, **4**, 91–92 (1931).—The disappearing-filament type of optical pyrometer is regarded as the most convenient and accurate instrument. Resistance and surface pyrometers are also described. H.H.S.

An automatic p_H recorder. CHARLES MORTON. *Chem. & Ind.*, **50** [48], 436–38 (1931).—The instrument described gives a continuous record of changes in hydrogen-ion concentration and may be arranged to operate warning signals whenever the permissible limits of p_H variation are exceeded. The general scheme of connections is shown in a diagram. G.R.S.

Absolute-pressure recording gage. BRISTOL CO. *Elec. World*, **98** [24], 1068 (1931).—A direct-reading single-pen, absolute-pressure gage of the recording type

eliminates any possibility of confusion or delay resulting from applying barometric corrections to vacuum readings. The actuating mechanism is described. G.R.S.

Temperature and humidity control in cement testing. H. S. MATTIMORE. *Instrument World*, **4**, 101 (1931); for abstract see *Ceram. Abs.*, **10** [6], 443 (1931). H.H.S.

Industrial measurement of temperature and volume. A. DODD. *Instrument World*, **4**, 87 (1931).—The human element having proved inadequate, a number of instruments of increasing excellence have come into general use. For volume, the Pitot tube, the Venturi tube or orifice plate, and various flowmeters are described. For temperature, the evolution of thermometers and pyrometers is detailed. H.H.S.

Automatic temperature regulators. S. HELD. *Chaleur ind.*, **12**, 383–90 (1931); see also *Ceram. Abs.*, **10** [10], 722 (1931). A.J.M.

A clock-controlled constant-frequency generator. A. B. LEWIS. R. P. 406; Bur. Stand., *Jour. Research*, **8** [1], 141–57 (1932).—A synchronous motor-generator set is described in which the motor is forced to rotate in synchronism with signals from a standard clock circuit. R.A.H.

New type of level. C. FABRY. *Instrument World*, **4**, 119 (1931).—In place of the usual air-bubble spirit-level, interference rings produced on oil contained in a spherical-bottomed platinized glass vessel are used. Great precision is given. H.H.S.

Turbine blowers in coke and gas works. WILLY BENCKER. *Brennstoff-Chem.*, **12** [24], 472–74 (1931).—Large turbine blowers driven at high speeds by electric motors or by steam turbines are advantageously used as suction pumps in the transfer of large amounts of gas in coke and gas plants. Illustrated. J.L.G.

Accurate air separator for fine powders. P. S. ROLLER. *Ind. Eng. Chem.* [Anal. Ed.], **3** [2], 212–16 (1931); for abstract see *Ceram. Abs.*, **10** [6], 448 (1931). R.G.M.

Recirculating-lubricating systems. FRED H. LOW. *Maintenance Eng.*, **90** [2], 66–68 (1932).—Different types of recirculating-lubricating systems designed to clean, lubricate, and cool the bearings concerned are described. Illustrated. J.L.G.

Variable voltage control of motor speed. E. C. DIEFFENBACH. *Maintenance Eng.*, **90** [2], 60–63 (1932).—Generator voltage control may be used advantageously to give (1) adjustable speed control for a single motor, (2) adjustable speed control for a fleet of motors, (3) overload protection without circuit breakers in the armature circuits, (4) reduction of surges on the power line by fly-wheel motor-generator set and liquid-type slip regulator, and (5) regeneration and dynamic braking control. J.L.G.

Hydrogen-ion determinations. ANON. *Power Plant Eng.*, **35** [24], 1217 (1931).—Hydrogen-ion concentration measurement can be rapidly made by the use of the quinhydrone electrode, balancing the unknown potential against that of a known potential on a potentiometer. Such an instrument has been developed by W. J. Youden of the Boyce-Thompson Institute of Plant Research in Yonkers, N. Y., and manufactured by W. M. Welch Mfg. Co. E.P.R.

Electric-magnetic counter. ANON. *Elec. World*, **98** [24], 1068 (1931).—The counters can be furnished for various voltages, a.c. or d.c., equipped with straight shunt coil or series, the coil consuming approximately 8 watts. It is designed for continuous duty, and can be used on any equipment where electrical contacts can be actuated. G.R.S.

Power formulas for chain conveyers and elevators. LINK-BELT CO. *Rock Prod.*, **35** [2], 38–39 (1932).—Formulas and information on turning efforts, coefficients of friction, chain stresses, and horse power of chain conveyers and elevators are given. W.W.M.

Application and design of the floating drive for conveyers. N. H. PREBLE. *Maintenance Eng.*, **90** [1], 7 (1932).—The floating drive secures exact synchronization of speed and power between driving units on the multiple drive of a single-chain overhead conveyer through a system of springs and clutch. Illustrated. J.L.G.

Handling by tramrail in the mill room. ANON. *Ceram. Ind.*, **18** [2], 127 (1932).—The tramrail system in the mill room of the Mansfield (Ohio) Vitreous Enamel Products Co. is described and illustrated. W.W.M.

BOOKS AND BULLETIN

Wave-Length Tables for Spectrum Analysis. F. T. TWYMAN AND D. M. SMITH. 2d ed. 192 pp. Adam Hilgar Ltd., London, 1931. Price 14s 6d. Reviewed in *Instrument World*, **4**, 110 (1931). H.H.S.

Treatise on Optical Pyrometry. (Traité de pyromètrie optique.) G. RIBAUD. 488 pp., 163 figures. Published by Revue d'Optique, Paris. Reviewed in *Chaleur ind.*, **12**, 396 (1931). A.J.M.

Chromium plating of steel for wear resistance at high temperatures and high current densities. A. WILLINK. *Trans. Electrochem. Soc.* [Preprint], **61**, 8 pp. (1932).—To produce a Cr plate which will show a high wear resistance, the bath containing about 250 g./l. CrO_3 and 2.3 g./l. of H_2SO_4 is recommended. It should be operated at a current density of 100 to 325 amp./sq. dm., and at 60 to 75°. Under these conditions the throwing power is better than at lower temperature and current density. The importance of having the steel surfaces clean before plating is emphasized. Alkali cleaners are objectionable on account of the alkaline film which remains and adheres to the steel surface. A "vapor degreaser" is described which employs trichloroethylene as the solvent. Control of the plating solution by periodic analyses is advocated. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Electric furnace. CHARLES WINSER AND R. M. CATTERSON-SMITH. *Pottery Gaz.*, **57** [656], 226–27 (1932).—A new rotary electrical kiln for the firing of glost ware up to a temperature of 1140°C would have an outside measurement of 42 ft. and would consist of fifteen independent tunnel trucks, forming a traveling heating tunnel. The measurements of the inside section of the tunnel would be 18 in. wide by 19 in. high. Heating is supplied by chrome-nickel elements. A circular sand bath is employed for preventing heat losses downwards or updrafts. Other constructional and operating details are given. E.J.V.

Electric furnace improvements. F. HORNER. *Mech. World*, **91** [2350], 63 (1932).—There are two new features in the construction of Wild-Barfield electric furnaces, one of which concerns the renewing of the heating units which are usually held in position by means of nickel-chrome ties or refractory pieces cemented to the fireclay walls. Considerable time may be occupied by the furnace in cooling before it is possible to remove the anchored pieces, but these makers have devised a method of quick repair while the furnace remains at working temperature. Another improvement consists of low-temperature furnaces with forced air circulation and a device for indicating when the work is uniformly heated. E.P.R.

Practical observations on operation of periodic kilns. P. DE GROOTE. *Céramique*, **34** [520], 146–54 (1931).—For rapid firing it is necessary to (1) operate the fires in order to obtain an adequate combustion rate and (2) secure a uniform distribution of temperature in the kiln. Uniform horizontal distribution can be obtained by rational distribution and proportioning of floor flues. Vertical uniformity may be obtained in part by (1) increased draft to produce a longer flame or (2) decreased draft so as to have pressure throughout most of the kiln. G. considers that (1) is apt to be more dangerous and argues that the result obtained depends on the air resistance of the fuel bed. With a clean fuel bed, the effect of pressure in the kiln is to keep the base as hot as the crown and

to prevent the entrance of cold air through cracks in the kiln walls. G. describes in detail and illustrates with charts the procedure followed in firing a kiln quickly and at the same time having a final temperature difference between top and bottom of only 20°C. It has been found that the CO_2 content of the combustion gases is a valuable indication of the temperature of the gases leaving the fuel bed and by proper regulation it has been found possible to avoid the failure of fire-box refractories. Cone 14 shows only a slight inclination at the side of the fire when cone 13 is down in the kiln. As a further example, G. describes the firing of a large kiln to cone 13 and maintaining oxidizing conditions at all times. Many cones were distributed through the setting and indicated a maximum difference in temperature of 35°C. Design data for a number of downdraft kilns in which such results were obtained are given in the following table. The density of setting was from 400 to 500 kilos per cu. m. and the kilns were fired to 1380 to 1400°C.

KILN DESIGN DATA

Capacity (cu. m.)	Diameter (m.)	Height to spring of crown (m.)	Firing time (hr.)	Rate of combustion (kg. of coal of 7000 cal. per hr.)	Total grate area (sq. m.)	Total area of floor flues (sq. m.)
10	2.40	1.92	18	163	2.00	0.180
20	3.40	1.92	20	252	3.00	0.270
30	3.95	2.11	21	318	3.68	0.335
40	4.30	2.40	22	377	4.24	0.393
50	4.60	2.63	23	420	4.62	0.436
60	4.85	2.85	24	460	4.95	0.471
70	5.07	3.05	25	489	5.20	0.500
80	5.30	3.20	26	513	5.40	0.520
90	5.50	3.32	28	532	5.55	0.535
100	5.70	3.42	30	551	5.68	0.547
110	5.87	3.54	32	566	5.78	0.556
120	6.05	3.62	34	579	5.85	0.563
130	6.20	3.73	36	590	5.90	0.570

The paper is followed by a discussion on G.'s previous paper by R. Morel d'Arleux in which d'A. stresses the importance of radiation in the transfer of heat from sagger to ware and of the mode of setting on the flame travel in the kiln. See also *Ceram. Abs.*, **10** [11], 800 (1931). A.E.R.W.

Gas tunnel kilns in ceramics. G. BENFEY. *Keramos*, **10** [25–26], 665–68 (1931).—B. discusses the advantages of tunnel kilns using gas over kilns of other types. A short description of tunnel kilns used for firing grog brick, face clinker, porcelain, stoneware, and wall plates is given. M.V.K.

Continuous gas-fired bisque and glost kilns. ELECTRIC FURNACE CO. *Ceram. Ind.*, **18** [2], 133 (1932).—The trade name of this kiln is "Elfurno." It is described and advantages claimed for it are listed. The company also recently announced a continuous decorating kiln for use with either gas or electric heat. W.W.M.

Recent improvement in tunnel kilns. ANON. *Brit. Clayworker*, **40** [477], 358–59 (1932).—The chief errors in early tunnel kilns were as follows: (1) the preheating zone was too short, (2) the cooling zone was too short, and (3) the distribution of the flames and hot gases in the heating zone was defective. The semidirect-fired kiln, both straight and circular in shape, is discussed. The use of electricity instead of gas for heating tunnel kilns has the following advantages: (1) a much smaller quantity of air and gas is passed through the kiln, (2) the control of the temperature can be almost automatic, and (3) wear and tear of the kiln structure is reduced to a minimum. R.A.H.

Chief characteristics of tunnel kilns. B. G. ULCH. *Ceramics & Glass*, **7** [10], 26–29

(1931).—U. discusses the properties of tunnel kilns and their advantages over chamber and circular kilns. M.V.K.

Kilns for common and hard-fired brick. C. HEUER. *Tonind.-Ztg.*, **55** [92], 1273–74; [94], 1301–1303 (1931).—Diagrams are given for different kilns to fire common and hard-fired brick. A comprehensive comparison is made between the amounts of heat necessary to fire ceramic products in different types of kilns. The results of the paper are summarized in two tables. See also *Ceram. Abs.*, **11** [2], 127 (1932). W.M.C.

Temperature distribution in industrial furnaces. WIRT S. SCOTT. *Elec. Jour.*, **28**, 668–72 (1931).—A comprehensive investigation of electric and fuel-fired furnaces showed wide variation between temperatures as recorded on control charts and those actually existing inside furnaces in operation under normal conditions. The furnaces investigated were all in first class condition, but varying in age from 3 months to 10 years. An electric furnace can be made to operate with machine-like precision with close temperature control, whereas gas-fired furnaces are not evenly heated. (*C.A.*)

Multiple recuperator system in brick kilns. A. CARENA. *Ind. Silicati*, **9** [8], 12–15 (1931).—The advantages of the new multiple recuperator system of air and smoke in brick kilns with continuous operation are (1) economy of fuel obtained, (2) improvement in the quality of the ware, and (3) decrease in waste and injured ware. M.V.K.

Temperature distribution in a ring kiln. ANON. *Tonind.-Ztg.*, **56** [3], 30–31 (1932).—The temperature was measured at different places of a ring kiln by means of thermometers and optical pyrometers. A heat balance is derived from the values obtained. W.M.C.

Roman kilns at Throlam. T. SHEPPARD. *Pottery Gaz.*, **56** [654], 1653–54 (1931).—Pottery kilns used in the early years of the Christian Era at Throlam, in the middle of the Vale of York, East Yorkshire, have been unearthed. The walls were 2 ft. thick and composed of puddled yellow clay. The kiln floor stood 1 ft. 8 in. above the furnace floor. A number of irregular lumps of baked clay was used to separate the vessels as set in the kiln. See also *Ceram. Abs.*, **10** [7], 479 (1931). E.J.V.

Reactions of sulphur compounds in boiler furnaces. H. F. JOHNSTONE. *Ind. Eng. Chem.*, **23** [6], 620–25 (1931). R.G.M.

Use of waste heat from kilns for roofing tile. R. FRANZMEIER. *Tonind.-Ztg.*, **56** [4], 45–47 (1932).—Several drawings show means of using the waste heat of periodic kilns for preheating the products before the proper firing period starts. W.M.C.

Relations between the technique of firing and colloid chemistry. RAPHAEL ED. LIESEGANG. *Feuerungstechnik*, **20** [1], 2 (1932).—L. points out that the firing technician will gain many pointers from colloid science. M.V.K.

Gas firing of pottery. ANON. *Gas Jour.*, **196** [3578], 740 (1931).—Experimental gas furnaces for firing of pottery are in the initial stages at the Etruria works. The first big industrial work attempted in Stoke-on-Trent was firing of electrical porcelain. Time of firing was much reduced by gas. Attention was then given to the firing of tile. The furnace constructed had a working space of 10 ft. by 4 ft. and held approximately 80 sq. yd. of fancy glazed tile. The furnace could be placed, fired, and drawn in 24 hr. Gas, without primary air, was admitted to the furnace through side ports. Oxidizing atmosphere was maintained throughout the furnace by means of special arrangements by air supply without relying on the velocity of the gas at injectors for the air required. The temperature range of these furnaces was from 800 to 1400°C, and 1700°C with special construction of the furnace. The entire capacity of the working space was maintained within 5° of uniform temperature. G.R.S.

Temperature distribution in the ground under a brick kiln and the importance of the underground water level. HJALMAR GRANHOLM. *Tegel*, **19** [1], 2–7 (1929).—Equations which describe approximately the temperature distribution in the ground with

periodic variations of surface temperature and with steady conditions are discussed in detail. A specific numerical example is given to illustrate the method of making calculations. G. shows that the level of underground water is of importance because if it occurs above a certain depth, which is dependent on dimensions and temperature conditions, damage to the kiln and excessive loss of heat will result. H.F.V.

Manual fuel valve. AUTOMATIC TEMPERATURE CONTROL CO. *Chem. Met. Eng.*, **38** [11], 671 (1931).—A manually operated fuel valve is capable of giving close regulation of oil fuels at flow rates of 1 qt. to 450 gal. per hour. Construction of the valve is given. See also *Ceram. Abs.*, **10** [1], 51 (1931). G.R.S.

Firing flowerpots. ANON. *Tonind.-Ztg.*, **55** [92], 1275–76 (1931).—Different methods of placing flowerpots in a furnace are discussed. Illustrated. W.M.C.

Fuel process. ANON. *Mech. World*, **90** [2345], 580 (1931).—Fuel for the Italian State Railways is to be provided by a new process of low-temperature carbonization of coal perfected in Sheffield by Piero Salerni, representing the Italian government, and R. V. Wheeler, head of the Dept. of Fuel Technology at the University of Sheffield. Eventually all bituminous coal imported into Italy will be so treated, with the exception of coal to be used for the making of city gas. The coals most suitable for the process are British. The Salerni system is new in the sense that, both in regard to the treatment of bituminous coal and the plant used for that treatment, methods are employed that have not hitherto been used. The process is designed to produce smokeless fuel of high density for domestic and industrial use, in addition to oil as a by-product. E.P.R.

Recent developments in fuel technology. I. R. WIGGINTON. *Fuel Sci. Prac.*, **10** [8], 341–43 (1931).—W. discusses the following developments: (1) collection of fuel dust, (2) a new heat-insulating material composed of crumpled aluminum foil (this material has an apparent specific gravity of only 0.003 and a thermal conductivity of about twice that of air), (3) wet gas purification, and (4) automatic gas analysis using the gravimetric principle. **II.** *Ibid.*, **10** [10], 421–23 (1931).—W. discusses the following developments: (1) the use of pulverized fuel in marine boilers, (2) oil from acetylene, (3) precision thermometry, and (4) a reversed heat-engine used for heating purposes. **III.** *Ibid.*, **10** [11], 461–63 (1931).—W. discusses (1) the excess of oil, (2) the coal situation, (3) air heating by disphenyloxide, (4) dust separation from chimney gases, and (5) the influence of burned coal products on cancer. **IV.** *Ibid.*, **10** [12], 501–503 (1931).—W. discusses (1) butane-air gas, (2) smoke elimination, (3) unusual fuels, and (4) purification of coal gas. See also *Ceram. Abs.*, **9** [9], 772 (1930). R.G.M.

Measures and principles in fuel chemistry work. I. H. GRÜSZ. *Brennstoff-Chem.*, **12** [22], 434–36 (1931).—A survey is presented of methods of measuring the temperature, pressure, amount, and concentration of substances met with in fuel chemistry work. Under temperature, the range and use of expansion thermometers, resistance thermometers, and thermocouples are explained. Automatic temperature regulators are described. The radiation- and disappearing-filament types of optical pyrometers are explained. Under pressure various types of manometers and methods of automatic pressure control are mentioned. Under concentration, the electric gas tester which measures gas concentration by measuring the heat conductivity of the gas is described. The different automatic gas analysis methods based on the absorption principle are mentioned. Illustrated with photos and diagrams. **II.** *Ibid.*, **12** [23], 453–54 (1931).—Flowmeters for gas measurement, oil-measuring devices, calorimeters, gas-density recorders, viscosimeters, flash- and fire-point apparatus, gas-moisture measurement, temperature measurement, and central station control are briefly presented. Devices on the market for measuring and controlling these factors are mentioned. Illustrated. J.L.G.

Nature of dust in combustion and other gases. ANON. *Queensland Mining Jour.*, **32**

[11], 437 (1931).—From the composition of the average fine dust contained in chimney gases, both in connection with mechanical stoking and pulverized fuel firing, collectors will remove 70 to 95% of the total, according to the conditions. As a result of taking hundreds of microphotographs, such dust is found to contain white, round, opaque, cellular bodies, transparent, glass-like particles, and yellow to brown crystals, all of which are ash particles that have been melted. A portion of the dust, both from stoker-fired and pulverized-fuel furnaces, will also be found to consist of coked (partially burned) coal of various shapes and sizes, black opaque globular bodies of unknown origin, and unburned coal particles. A large proportion of the white opaque globular bodies and transparent particles are sufficiently light to float on water; this shows the difficulties of trying to remove dust from gases by use of water sprays. The opaque white particles usually predominate in the dust from pulverized fuel boilers, being especially abundant in the dust from boilers using turbulent burners. These particles are formed from the ash portions having a high melting point, and probably result from the very fine ash particles in the plastic or semimolten stage sticking together in their passage through the combustion chamber. Thus the complete globules often have smaller ash masses adhering, or sometimes specks of unburned coal. The clear glass-like particles are formed from the lower melting point ash, which has fused completely, being hollow spheres with extremely thin walls of molten silicates (glass). The suggestion has been made that these fragile glass-like bodies result from the passage of gases and vapors from a burning coal particle through an outer skin of molten ash. In general, both the hollow glass-like spheres and the white opaque particles will float on water, but the former are very fragile and the latter may become water-logged, so that portions of the hollow glass-like spheres and some of the white particles will be found among the dust which sinks. The bulk of the latter, however, are black, hollow globules of bituminous coal that have been melted but not carbonized to any appreciable extent, coke in various amorphous forms, mostly of irregular shape, and also coke in the form of rectangular pieces, lightish in color; unburned coal is represented by black needles with sharp edges. E.P.R.

Significance of high and low heating values of natural gas fuels. PALMER B. PLACE. *Power Plant Eng.*, **35** [8], 447–49 (1931).—Heating values of a gas may be given in terms of B.t.u. per cu. ft. at some temperature and pressure or in terms of B.t.u. per lb. and in both cases the value may be "high" or "low." It is necessary, when comparing gases, that their heating value be on the same basis. Water vapor, the product of combustion of hydrogen, condenses and gives up its latent heat of condensation. The heating value determined in a calorimeter includes this latent heat and is termed the high or gross heating value of the fuel. In commercial steam generation, the exit gases are never cooled to the point of condensation so the heat of condensation of the moisture is never available. For this reason the latent heat is sometimes deducted from the high heat value and the lower value is termed the low, net, or available heat value of the fuel. The difference between combustible and noncombustible carbon and hydrogen should be understood. The combustibles are carbon and hydrogen of the hydrocarbons and the noncombustibles may be nitrogen, oxygen from carbon dioxide and water vapor, carbon from carbon dioxide, and hydrogen from water vapor. Inerts in fuel gases have somewhat the same effect as ash in solid fuels. Gases having a high percentage of noncombustible material require extra handling of the raw gas, yield a somewhat lower temperature when burned, produce a slightly larger quantity of waste gases per B.t.u., and require a longer time to complete combustion; hence they require a larger furnace. E.P.R.

Specific heat of gases. H. v. JÜPTNER. *Feuerungstechnik*, **20** [1], 2–4 (1932).—A theoretical discussion illustrated by formulas and tables on the specific heat of gases is given. M.V.K.

Attempts to Bertinierize lignite. C. STAEMMLER. *Brennstoff-Chem.*, **12** [23], 449–51 (1931).—A short review of the attempts to improve lignite by artificial carbonization is presented with emphasis on the relation of this process to the production of illuminating gas. Results attained by different methods of treatment are tabulated. J.L.G.

Producer gas manufacture. I. The Sauvageot producer. M. BORGUET. *Rev. belge ind. verrières*, **2**, 129–32 (1931).—Combustion, the chemistry of producer gas formation, yield of a gas producer, combustibles, conditions of operation, classification of gas producers, methods of supplying air, and types of grates are discussed. **II.** *Ibid.*, **2**, 150–53 (1931).—Operation of producers is again treated. The Sauvageot producer is described and illustrated. A table gives the results of tests on this as well as two other types of producers. A.J.M.

Attempts to purify illuminating gas in a revolving drum. P. FRITZSCHE. *Brennstoff-Chem.*, **12** [24], 468–69 (1931).—The use of a horizontal revolving drum for the continuous dry purification of illuminating gas is discussed. Constant movement of the powdery purification material is secured by a system of vanes and paddles. The direction of the gas flow is opposite to that of purification material. Favorable results were secured in a small revolving drum purifier of this type. Illustrated. J.L.G.

Path of the gas in coke ovens. G. E. FOXWELL. *Brennstoff-Chem.*, **13** [1], 1–6 (1932).—The question is investigated by two methods, a direct and an indirect one, and conclusions are drawn. J.L.G.

Influence of the coal constituents on the amount and nature of the gases in the coking process. HORST BRUCKNER AND WALTER LUDEWIG. *Brennstoff-Chem.*, **12** [24], 465–67 (1931).—The coal was separated into $\alpha,\beta,\lambda_1,\lambda_2,\lambda_3+_4$ constituents by a solution method described by Cockram and Wheeler in the *Jour. Chem. Soc.* [London], 1927, S. 700. These fractions were degassed separately in a vacuum and the respective amounts of gas measured and analyzed. The ultimate analyses of the different coal fractions as well as the analyses of the different gases given off are tabulated. The total gas from the separate parts of the coal was less in amount than that from a like quantity of coal not so separated. This indicates a reaction between the coal constituents to give larger amounts of gas. A series of artificial mixtures of the previously separated parts confirmed this reaction. J.L.G.

Metallic ions as catalysts for the removal of sulphur dioxide from boiler-furnace gases. H. F. JOHNSTONE. *Ind. Eng. Chem.*, **23** [5], 559–61 (1931). R.G.M.

Determination of the true composition of coal. FRITZ SCHUSTER. *Brennstoff-Chem.*, **12** [22], 425–26 (1931).—A method for the determination of the true composition of coal is described in which the errors of the usual methods are eliminated. The process depends on the separation of the sample by means of heavy liquids into two parts, one rich in ash (heavy) and one poor in ash (light). The ash content of each is determined and two or three mixtures are made up in which the ash content varies regularly. These are analyzed for the different elements and the percentages of each are plotted as ordinates against the corresponding values of ash content as abscissas. The intersection of the resulting curve (straight line) with the ordinate axis gives the values of the elements in the ash-free sample. The direct determination of nitrogen in the separate samples can be dispensed with since it will be the difference between 100 and the sum of the values for the remaining elements. The true ash content of the original sample can likewise best be determined graphically. The hygroscopic water is determined according to a method by Terres and Kronacher (see *Ceram. Abs.*, **9** [12], 1081 (1930)). A comparison of results secured by usual methods with those obtained by the new method is given. J.L.G.

Determination of moisture in coal by drying in a vacuum. R. VONDRACEK AND L. MOSENDZ. *Brennstoff-Chem.*, **12** [23], 445–46 (1931).—Vacuum drying at temperatures

below 100°C was found to offer no advance over present practice since a new source of loss is introduced. Whether this is chiefly due to increased volatility of the existing hydrocarbons under reduced pressure or to a speeding up of destructive distillation was not determined. A higher weight loss was obtained through drying in a vacuum (0.5 to 1.0 mm. Hg) at 60°C than in air at 105°C. At 100°C the weight loss for lignite coal heated in a vacuum exceeded by 2% the value obtained by heating in air at 105°C. For anthracite, the excess weight loss in vacuum was 0.5%. J.L.G.

Combustion temperature of powdered coal and the possibility of the coal-dust engine. T. SUWA. *Mech. World*, **91** [2350], 56–58 (1932).—With the object of confirming the possibility of the coal-dust engine, the combustion properties of various kinds of coal, lignite, and charcoal were investigated under high pressure. A special apparatus for determining the auto-ignition temperature was designed for working under high pressure. The auto-ignition temperature curve obtained indicates the combustion characteristics of pulverized fuel as well as of Diesel oil, and the influence of injection pressure, shape of nozzle, fineness of the fuel, and oxidation during storage were ascertained. E.P.R.

Mechanism of the combustion of powdered coal. A. GREBEL. *Chaleur ind.*, **12**, 363–71, 424–26 (1931); see also *Ceram. Abs.*, **10** [10], 723 (1931). A.J.M.

Errors in the sampling of coal from wagons. N. SIMPKIN. *Mech. World*, **90** [2246], 595–96 (1931).—Results of tests carried out by the Lancashire and Cheshire Coal Research Assn. are given. E.P.R.

Cooling smoke. S. GUSS. *Glashütte*, **60** [51], 935–37; [52], 954–56 (1930); **61** [1], 8 (1931); *Glastech. Ber.*, **9** [2], 110–11 (1931).—G. describes the researches of Keppeler, Loeber, and Zschacke on cooling smoke and the chemical action of cooling, and describes his own investigations on this question. The action of wood firing, oil firing, coke, and flue ashes is discussed. M.V.K.

Purification of crude benzol with concentrated and 80% sulphuric acid. E. MOEHRLE. *Brennstoff-Chem.*, **13** [1], 6–9 (1932).—Experiments showed that washing with 80% acid had the same general effect on the indene, styrol, and tetrahydrobenzol in the crude benzol as did washing with concentrated acid, although the action of the weaker acid was correspondingly weaker. The concentrated acid removed the olefines while the 80% acid did not. The experiments seem to indicate favorable results for the use of 80% acid in purifying benzol for motor fuel. J.L.G.

Resinization of motor benzol. H. A. J. PIETERS AND H. S. VISSER. *Brennstoff-Chem.*, **12** [24], 470–72 (1931).—A study was made of the factors which influence the formation of resin in the distillation of benzol. J.L.G.

Factors to consider in buying fuel oil. IV. ANON. *Brick Clay Rec.*, **80** [1], 46 (1932).—Although oil is sold by the gallon or barrel, the B.t.u. is based on the pound so that an adjustment must be made in determining the cost of oil per B.t.u. The heat value of fuel oil ranges from 17,000 B.t.u. per pound for highly cracked fuel oil from a coking still to as high as 19,700 for a straight reduced paraffine base oil. For Parts II and III see *Ceram. Abs.*, **10** [11], 801 (1931). E.J.V.

Contributions to the hydrogenation of naphthalene, anthracene, and phenanthrene. H. WINTER AND G. FREE. *Brennstoff-Chem.*, **12** [23], 451–53 (1931).—The work was carried on in an autoclave. Results are shown graphically and in table form. All hydrogenation products contained more hydrogen than the remaining products. Hydrogenation products are, on the whole, tetrahydroderivatives. Hydrogenated compounds with more than four attached hydrogen atoms could not be determined (phenanthrene?). Besides the hydrogenation products, there arise also benzol-like decomposition products in greater or less amount. Naphthalene and anthracene, but not phenanthrene, also gave high-boiling pitch-like decomposition products. Aluminum chloride

in the case of naphthalene increased the yield of liquid products, however, at the same time increasing the decomposition. The addition of aluminum chloride to naphthalene and anthracene in an asbestos-lined autoclave brought about the complete decomposition into gaseous hydrocarbons and coke. J.L.G.

Determining the physical quality of coke. JOACHIM KÄRRNER. *Feuerungstechnik*, **19** [12], 194–96 (1931).—K. discusses (1) the heat value and temperature of combustion of coke, (2) chief requirements for coke of good quality, *i.e.*, low content in ashes and water, high solidity, and low abrasion, (3) new methods for determining solidity and abrasion, and (4) porosity and combustibility. M.V.K.

Storing and handling fuel. ANON. *Power Plant Eng.*, **35** [24], 1177–78 (1931).—Methods of storing and handling fuel in power plants preparatory to burning have not changed or developed materially during the past year. All plants shown on an accompanying tabulation possess some equipment for weighing or otherwise measuring the fuel. A clear indication is shown that progress has been made in measuring plant performance, especially in the industrial power plant. E.P.R.

BULLETINS

Determining the gas, coke, and by-product making properties of American coals with results on a Taggart-bed coal from Roda, Wise County, Va. A. C. FIELDNER, J. D. THIESSEN, E. B. KESTER, AND W. A. SELVIG. Bur. Mines, *Bull.*, No. 344. 107 pp., 53 illustrations. Price 50¢ from Supt. of Documents, Govt. Printing Office, Washington, D. C. R.A.H.

Power Station Chemistry. ANON. Nat. Elec. Light Assn., *Pub.*, No. 14; *Power Plant Eng.*, **35** [10], 582 (1931).—This publication, recently issued by the Prime Movers Committee, Engineering National Section, describes methods for the sampling and testing of bulk and powdered coal and laboratory methods for the sampling and testing of power plant steam and water supplies, and stresses the necessity for the proper sampling of water and steam in boiler systems. E.P.R.

Safety in pulverized fuel systems. ANON. *Power Plant Eng.*, **35** [11], 609 (1931).—Regulations for the installation of pulverized fuel systems, issued by the National Board of Fire Underwriters and approved by the American Standards Assn., are covered in bulletin *Z12-a*-1930. These regulations are designed for application to new installations or for making alterations or extensions to existing plants. E.P.R.

PATENTS

Gas burner. NELSON T. BRANCHE. U. S. 1,841,465, Jan. 19, 1932.

Electric-furnace resistor. JAMES KELLEHER. U. S. 1,841,537, Jan. 19, 1932.

Process of producing electrical resistance element. FERDINAND EICHENBERGER. U. S. 1,842,088, Jan. 19, 1932.

Geology

Recognizing minerals. H. R. BERINGER. Mining Publications, Ltd. Reviewed in *Refrac. Jour.*, **7** [12], 514 (1931).—B. determines the hardness and the specific gravity of the mineral, and from these two properties and with the aid of tables narrows down the search to two or three minerals. These are distinguished by other tests which are briefly described. The readers must be acquainted with Mohs' scale and how to use it and have a fair knowledge of crystallography, the use of the blowpipe in testing,

and several other tests. It is probably necessary for a reader to have had some definite instruction in testing minerals and some practical acquaintance with good specimens, otherwise he might easily reach wholly erroneous conclusions. The total number of minerals mentioned is large. Most of those in which clayworkers are interested are included, though there is no mention of clay, cristobalite, zirconia, or plagioclase. Sand and gravel are mentioned but not described. E.P.R.

Crystal structure of the monoclinic pyroxenes. B. E. WARREN AND J. BISCOE. *Z. Krist.*, **80** [5–6], 391–401 (1931).—From X-ray diffraction study and consideration of chemical composition it is shown that the representative substances, diopside, hedenbergite, augite, clino-enstatite, acmite, jadeite, and spodumene, are all similar in crystal structure. These substances may be taken as representative of the monoclinic pyroxene group with diopside as the type structure. The chemical composition is represented by the general formula $X_mY_{2-m}(Si, Al)_2$ (O, OH, F)$_6$, where X = (Ca, Na, K), Y = (Mg, Fe, Al, Ti, Li), and m tends to be 1.0 to 0. Wollastonite and pectolite are shown to have unit cells wholly different from those in the monoclinic pyroxene group. The true symmetry of the structure is found to be triclinic rather than monoclinic as had been generally supposed. The structures of these substances are definitely different and there appears to be no reason why they should be classed with the monoclinic pyroxenes. G.R.S.

Estimation of acid plagioclase with the aid of the zone method. H. EBERT. *Mineral. petrog. Mitt.*, **42** [1], 8–26 (1931).—For plagioclase with 0 to 40% anorthite a rotation method has been devised so that in a working process the estimation of anorthite content and the twinning law may be permitted. It necessitates an expansion of the Rittmann zone method and depends upon the agreement of the extinction curves of all individuals which are so twinned that their (010) faces lie parallel. A series of diagrams and examples illustrate the method. G.R.S.

Extraction of potash from polyhalite. V. Production of syngenite and by-product magnesia. H. H. STORCH AND N. FRAGEN. *Ind. Eng. Chem.*, **23** [9], 991–95 (1931); for abstract see *Ceram. Abs.*, **11** [1], 56 (1932). R.G.M.

Geology development of Washington's nonmetallic-mineral resources. ANON. *Pit & Quarry*, **23** [9], 43–47 (1932). E.P.R.

Solution depressions in sandy sediments of the coastal plain in South Carolina. L. L. SMITH. *Jour. Geol.*, **39** [7], 641–52 (1931).—Numerous depressions occur near the inner margin of the coastal plain of S.C. which are not due to wind action or to any of the other common causes of depressions. Evidence is presented to show that they are a result of solution of iron and aluminium from sandy sediments by ground water. The solution is effected by organic acids resulting from decay of vegetation. Once started, solution is accelerated by increased dampness and increased growth of vegetation. G.R.S.

Waning of the last continental glacier in Denmark as illustrated by varved clay and eskers. S. A. ANDERSEN. *Jour. Geol.*, **39** [7], 609–24 (1931).—A study of the circumstances under which eskers and varved clay in southeastern Zealand, Denmark, were built has revealed that the ice remained as a stagnant body for many years before it finally melted away. Moraines, earlier regarded as deposits of the ice border, were deposited underneath the ice along a line of demarcation between the moving ice and a broad stagnant ice-border zone. This line was found in places probably more than 50 miles inside the true ice border. Four chains of eskers have been studied, and it has been shown that they are composed of similar successions of different links and that the corresponding links in each of the four chains were deposited contemporaneously just outside or partly inside the line. The chains are composed of a series of bows, each deposited during a single year. This has led to a determination of the inward

migration of the line during ten succeeding years and has resulted in an exact relative dating of the deposits and the events during the late Pleistocene development of that region. G.R.S.

Chemico-mineralogical and morphological study of the iron ores from the Revier Sulin in the Donets hard coal basin. D. SERDJUTSCHENKO. *Mineral. petrog. Mitt.*, **42** [1], 27–47 (1931).—The limonite iron ores of the Revier Sulin (north Caucasian region) are the products of a descending drainage of limestone. There are large, partly regular variations of the content of the ores in MnO_2, SiO_2, and $CaCO_3$ (calcite and aragonite). Gypsum formation and kaolinization of the adjoining clay slate are related to the process of ore formation. G.R.S.

Beryl deposits in Bavaria. W. LAMBRECHT. *Metall Erz*, **28** [12], 293–95 (1931); *Chim. & Ind.*, **26** [6], 1357 (1931).—A description is given of several beryl deposits in Bavaria. Crystals of beryl are found in superficial formations (conglomerates, a kaolinized feldspathic mass) covering white quartzites. M.V.K.

Kaolinite from the terminal moraine of Staten Island. PAUL F. KERR. *Amer. Mineralogist*, **17** [1], 29–34 (1932).—Microscopic examination, X-ray study, and chemical analysis agree in establishing the identity of the clay mineral constituents as kaolinite intimately mixed with fine feldspar and mica. The occurrence of the clay suggests that it was picked from the base of the Raritan formation by passing ice of the Pleistocene glaciation, transported a short distance, and left in the terminal moraine. Although such clays have been recognized as "kaolin" for some time, the clay mineral has not previously been correlated with kaolinite according to the modern definition. G.R.S.

Bauxite deposits in the Brazilian state, Minas Geraes. FRED W. FREISE. *Metall Erz*, **28** [21], 501–503 (1931).—A geographical and geological review is given. Some chemical analyses of typical bauxites are included. L.T.B.

Amphibolite of the southern Odenwalde and their relation to diorites and granites. V. LEINZ. *Mineral. petrog. Mitt.*, **42** [2], 82–135 (1931).—Between diorite and amphibolite convergence phenomena appear in almost chemically equivalent forms. If the amphibolite belongs in the younger granite it fits perfectly into the new conditions. There originated from the amphibolite either a hornblende-biotite schist or a purer biotite schist. These changes are described as they occur in the southern Odenwalde. G.R.S.

Contribution to the determination of the different forms of sulphur in South African coals and shales. P. E. ROUSSEAU. *Brennstoff-Chem.*, **12** [23], 446–49 (1931).—The literature of sulphur determinations on coals and shales is reviewed. The results of an investigation of five coals and four oil shales of South Africa are given. The best determinations of sulphate sulphur were made by extraction with 3% hydrochloric acid for 40 hr. at 60°C. The sum of the pyritic plus sulphidic plus the sulphate sulphur is best determined by extraction with nitric acid (specific gravity 1.12) for 72 hr. at room temperature. The iron-pyritic-sulphur correlation is constant with coals in certain cases. In the oil shales there is no correlation. Therefore the determination of pyritic iron as an index to the sulphur content of these shales is useless. J.L.G.

Subsurface oxidation of oil shales. K. LUTZ. *Brennstoff-Chem.*, **13** [1], 10 (1932).—L. presents evidence for the subsurface oxidation of shales based on the appearance and chemical analysis of an oil shale brought from a depth of 8m. Since deep-lying shales to which the ground water does not have ready access through cracks and fissures do not exhibit this oxidation, he attributes it to dissolved oxygen from the ground water or to this oxygen plus that furnished by soluble salts, such as those of iron and manganese, dissolved in the ground water. J.L.G.

Uses of borax. ANON. *Chem. Trade Jour.*, **88** [2293], 434 (1931).—Borax is used

in (1) refined cements, (2) glazing porcelain, (3) glazing earthenware products, (4) making enameled signs, hollow ware, etc., (5) making opal and flint glasses, and (6) glazing the surface of tile. M.V.K.

Diatomite and its uses. ANON. *Queensland Mining Jour.*, **32** [11], 448 (1931); see *Ceram. Abs.*, **11** [2], 131 (1932). E.P.R.

Kieselguhr. J. BURGER. *Chaleur ind.*, **12**, 681–85 (1931).—Diatomaceous earth is discussed from the viewpoints of occurrence, chemical composition, preparation, and uses. A.J.M.

Study of the wear on stones by transportation in water. F. W. FREISE. *Mineral. petrog. Mitt.*, **42** [1], 48–58 (1931).—The wear by transportation in water on different stones depends on their lack of hardness. On the basis of laboratory and field observations on a series of Brazilian stones (fresh and weathered) ability to withstand wear was determined. G.R.S.

BOOKS AND BULLETINS

The Study of Rocks. S. J. SHAND. Thomas Murby & Co., London, and D. Van Nostrand Co., New York, 1931. xi + 224 pp. Price 6s. Reviewed in *Amer. Mineralogist*, **17** [1], 40–41 (1932).—A brief summary is given of the various systems of classification of igneous rocks. The system presented by S. is a simplification using a combination of mineralogical and chemical characteristics containing only 56 rock names. A section of 129 pages is devoted to igneous (eruptive) rocks, one of 48 pages to sedimentary rocks, and a section of 35 pages to metamorphic rocks. Pertinent suggestions for reading are given at the end of each chapter. G.R.S.

Descriptive Petrography of the Igneous Rocks. Vol. I. Introduction, Features, Classification, and Glossary. ALBERT JOHANNSEN. Reviewed in *Amer. Mineralogist*, **17** [1], 41–42 (1932); for abstract see *Ceram. Abs.*, **10** [12], 860 (1931). G.R.S.

Examination of Fragmental Rocks. F. G. TICKELL. Reviewed in *Amer. Mineralogist*, **17** [1], 40 (1932); *Jour. Geol.*, **39** [6], 603 (1931); for abstract see *Ceram. Abs.*, **10** [8], 598 (1931). G.R.S.

The Ione Formation of California. VICTOR T. ALLEN. Univ. Calif. Pub., Dept. Geol. Sci., *Bull.*, **18** [14], 347–448 (1931); reviewed in *Jour. Geol.*, **39** [7], 693–94 (1931).—Originally the Ione formation included by definition three divisions which from top to base were (1) clay rock or tuff, (2) white or red sandstone, and (3) white clay, sand, and lignite. Allen, in redefining the formation, limits the name to the two lower divisions which are widespread and uniform. The entire paper represents a careful analysis. G.R.S.

Handbook of the Geology of Great Britain. Edited by J. W. EVANS AND C. J. STUBBLEFIELD. Reviewed in *Jour. Geol.*, **39** [6], 605 (1931); for abstract see *Ceram. Abs.*, **9** [2], 132 (1930). G.R.S.

Geological Map of the Earth. Prepared by FRANZ BEYSCHLAG AND THE PRUSSIAN GEOLOGICAL SURVEY. Reviewed in *Jour. Geol.*, **39** [7], 694–95 (1931); for abstract see *Ceram. Abs.*, **10** [8], 599 (1931). G.R.S.

Physics of the Earth. I. Volcanology. 77 pp.; **II. The Figure of the Earth.** 279 pp.; **III. Meteorology.** 289 pp. National Research Council, *Bull.*, Nos. 77, 78, 79 (1931). Reviewed in *Jour. Geol.*, **39** [7], 689–91 (1931). G.R.S.

Geophysical Abstracts. XXXII. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6583. 27 pp. (Free.) A monthly review is given of papers, books, and patents concerning methods and devices for geophysical prospecting. R.A.H.

Clay in 1930. JEFFERSON MIDDLETON AND K. V. HERLIHY. Bur. Mines, *Mineral Resources U.S.*, 10 pp. Price 5¢. (Separate chapter.) R.A.H.

Chemistry and Physics

Internal structure of solid oxygen-containing salts at high temperatures. I. General theoretical foundation. WILHELM JANDER. *Z. anorg. allgem. Chem.*, **192** [3], 286–94 (1930).—The solid oxygen-containing salts of the type MeR_4O_2 can be divided into four groups structurally: I. The structure is a pure ionic type. The points of the lattice are Me and R. The O-atoms surround R and form a complex ion ($NaClO_3$, $CaCO_3$, $NaNO_3$). II. The points of the lattice are occupied by Me, R, and O. The distance Me–O is equal to R–O. There are complexes in the crystal which may be considered to consist of MeO_4 and RO_4 ($3CaO \cdot Al_2O_3$). Between types I and II there is a series of transition compounds. III. The lattice consists of neutral molecules. IV. The O-atoms are not all equal in the lattice. Some are closer to Me and some closer to R so that in $MeRO_4$, the groups MeO and RO_3 may be distinguished ($NH_3 \cdot HF$ crystallizes in this form). This fourth type hardly occurs at room temperatures, but many compounds are transformed to this double oxide lattice on heating. These changes are indicated by the vibrations in crystals at high temperatures. The internal structure of salts may be explained by the study of the internal "place exchange," electrical conductivity, and reactions in the solid state. **II. Tungstates and molybdates of bivalent metals.** *Ibid.*, pp. 295–316 (1930).—For the study of the internal structure of O-containing salts, Mo and W salts were used. The experimental work reported here relates to the type of conductivity. The monoclinic compounds $NiWO_4$, $MnWO_4$, and $ZnWO_4$ show electron conductance in the temperature interval 600 to 1000°C. $MgWO_4$ shows poor conductance. At about 1000°, however, it seems to behave as an electron conductor. Monoclinic $CdWO_4$ and tetragonal $BaWO_4$, $SrWO_4$, $BaMoO_4$, $SrMoO_4$, and $CaMoO_4$ show ionic conductivity; that of $CaWO_4$ is very small. $SrMoO_4$ and $CaMoO_4$ decompose at high temperatures to form lower oxides so that the conductivity of those compounds cannot be determined with accuracy. The results of these experiments are then related to the internal structure of the compounds. $NiWO_4$, $MnWO_4$, $ZnWO_4$, $MgWO_4$, and the corresponding molybdates show a double oxide structure ($MeO \cdot WO_3$) between 600°C and 1000°C; while $CdWO_4$ and the alkali earth tungstates and molybdates have an ionic structure in the same temperature interval. In $CdWO_4$ there could also be an equilibrium between the ions Cd^{++} and $WO_4^{=}$ and the oxides CdO and WO_3. **III. Electrical conductivity, diffusibility, and reactivity of spinels in the solid state.** WILHELM JANDER AND WILHELM STAMM. *Ibid.*, **199** [1], 165–82 (1931).—It has previously been assumed that a material which crystallizes at low temperatures in a complex or ion lattice can be transformed to a double oxide lattice at higher temperatures, in which state the O-atom can be displaced closer to one element than to the other due to its vibration. Such a displacement can only take place by mutual rearrangement of atoms if the crystal lattice is not also to change. It is assumed that this change is easier in crystals of low symmetry than in those of high symmetry. In order to obtain more definite information, spinels which crystallize in the cubic system were chosen for study. The problem was to determine which of the atoms of the spinel was responsible for the inner "place exchange" at the higher temperatures. For the determination of the reactive groups, measurements of conductivity, diffusion phenomena, and reactions in the solid state were made. Conductivity studies on pure MgO, ZnO, and Al_2O_3 are described. These experiments show conclusively that the first two are electron conductors, while Al_2O_3 probably also is. The aluminates of Zn and Mg show ionic conductance, while the corresponding chromites show typical metallic conductivity. From diffusion experiments and reactions in the solid state it appears that the trivalent elements Al and Cr are more susceptible to the "place exchange" than divalent Zn

and Mg. These results prove that the spinels $MgAl_2O_4$ and $ZnAl_2C_4$ have an ionic lattice between 600°C and 1250°C. L.T.B.

Building crystal structure models. J. W. GRUNER. *Amer. Mineralogist*, **17** [1], 35–37 (1932).—Brass rods are used to represent valency bonds, the rods being soldered together. The junction points are positions of atoms and are covered by balls made from "plastic wood." After this material has set the balls are painted with enamel paint. The models are very rigid even when of large size. An example is given in building a model of sillimanite. A photograph shows the completed model. G.R.S.

X-ray crystal analysis. G. CADOGAN ROTHERY. *Elec. Rev.*, **110** [2824], 48 (1932).—Eighteen years ago X-ray crystal analysis was applied in England to the investigation of industrial problems. Much of the early practical work was devoted to the investigation of metals, especially steels and alloys. Many of the investigations touched upon the electrolytic deposition of metals, where there is often marked selective crystal orientation. This selective orientation of crystallites is not peculiar to metals, but is also found in rubber, cellulose, and silk which have been of use in researches on the characteristics and qualities of insulating materials. E.P.R.

International comparison of X-ray standards. L. S. TAYLOR. Bur. Stand., *Jour. Research*, **8** [1], 9–24 (1932).—Direct comparisons between the X-ray ionization standards of the U.S., England, Germany, and France are described. The small guarded field ionization chamber was used as the working standard and was transported to the several laboratories. Careful check of the instrument calibration at each laboratory showed no change due to transportation. The final agreement between the standards of the U.S., England, and Germany was $\pm 0.5\%$. The ratio between the International Röntgen and Solomon's Unit for hard radiation was 2.29. As a result of diaphragm discrepancies found in England, a study was made of diaphragms which tended to warp with age rendering accurate determination of their area difficult. R.A.H.

New lines in the K series of X-rays. WILLIAM DUANE. *Proc. Nat. Acad. Sci.*, **18** [1], 63–68 (1932).—New lines were found in the K series of X-rays of molybdenum and tungsten. J.L.G.

Industrial and chemical research with X-rays of high intensity and with soft X-rays G. L. CLARK AND K. E. CORRIGAN. *Ind. Eng. Chem.*, **23** [7], 815–20 (1931). R.G.M.

Crystallization surface of undercooled liquids; calculating the capability of crystallization. ELSNER V. GRONOW. *Sprechsaal*, **64** [53], 993 (1931).—The capability of crystallization, KV, of a substance is determined (according to Tammann) from the dependence of the temperature on the linear velocity of crystallization, KG, and the spontaneous capability of forming nuclei, KZ. The maximum of KV must lie between the higher temperature of the KG-maximum and the lower temperature of KZ. The exact calculation of the temperature of this maximum cannot be made from the superposition of the curves representing the KZ and the KG in dependence on the undercooling, because if both curves are combined they possess different and not comparable ordinates. It is possible, however, to ascertain mathematically and graphically the proper temperature function of KV from the KZ and KG curves, *e.g.*, it is possible to determine the temperature by which the total volume of the glass can be changed into the crystalline phase within the shortest time. With the assumption of spherulite, this results for the crystallized volume after z minutes: Vol. $kr = v\,(1 - \frac{v}{4}r^{3\cdot}z^4)\frac{\pi}{3}r^3z^4$; v is the number of nuclei per time unit and volume unit, and r is the linear KG. The usability of the formula is explained on numerical examples. M.V.K.

Relation between double refraction and crystal structure. W. A. WOOSTER. *Z.*

Krist., **80** [5–6], 495–503 (1931).—It is concluded that (1) all layer lattices except those containing OH groups have negative optical sign, (2) all chain lattices in which the chains are parallel to the optical axis are positive, (3) all strongly asymmetric groups doubly refract the light passing through them so that the electric vector of the ray having the higher index is parallel to the shortest bonds in the crystal, (4) all symmetrical groups give rise to a lower birefringence, (5) lattices made up of a three-dimensional-network of symmetrical groups have a low birefringence, (6) certain iron- and titanium-bearing substances have a high double refraction which is not due to marked asymmetry in the crystal structure. G.R.S.

Determining the size and shape of submicroscopical crystals with X-rays. R. BRILL. *Kolloid-Z.*, **55** [2], 164 (1931); *Glastech. Ber.*, **10** [1], 43 (1932).—The "half value of the width" of the X-ray interference is ascertained from the Debye-Scherrer photos with the help of a registering photometer. The "half value of the width" is a measure from which the number of the atoms and the size of crystals which act in the crystal lattice can be determined. Formulas for calculating the "half value of the width," the size, and the shape of submicroscopical crystals are given. M.V.K.

Entropies of a crystal and of its melt as related to temperature. G. TAMMANN. *Ann. Physik*, **5**, 107–12 (1930); *Internat. Bull. Information Refrigeration*, **11**, 32 (1931).—The thermodynamical relations between a crystal and its melt are explained by entropy diagrams. The curves seem to suggest that some substances may have two melting points. H.H.S.

Crystal structure of molybdenum trioxide, MoO_3. NORA WOOSTER. *Z. Krist.*, **80** [5–6], 504–12 (1931).—The crystal structure of MoO_3 was investigated by means of Laue and oscillation photographs. The oxide has a layer lattice, each layer being composed of parallel chains of distorted octahedra of O ions surrounding the Mo ions. The underlying lattice is Γ_0 and the space group is $\mathfrak{D}$(bnm), D_{2h}^{16}. The unit cell has the dimension, four molecules to the cell. The coördinates are given in a table. The parameters of the Mo have the values $u = 31°$, $v = 35°\,30'$. Those of O are $u = 31°$, $v = 35°\,30'$, $v' = 90°$, $y = 25°$. G.R.S.

Titanium minerals in very basic slags containing titanium. C. W. CARSTENS. *Z. Krist.*, **77** [5–6], 504–505 (1931).—Brownish yellow lattice crystals formed in basic aluminum slag appeared to be perovskite. The crystals were separated from the slag by treatment with soda followed by HCl. A small amount of another mineral was present in the undissolved residue. A chemical analysis of this residue showed SiO_2 1.67, TiO_2 37.73, Al_2O_3 22.57, and CaO 39.23. Mineralogical calculation indicated $CaTiO_3$ 61.60, $CaO{\cdot}Al_2O_3$ 30.54, $2CaO{\cdot}Al_2O_3{\cdot}SiO_2$ 7.61, and TiO_2 1.45. An X-ray examination showed a cubic mineral. The length of the edge of the elementary cube was $a = 3.795$Å, which is the same as that of the naturally occurring mineral perovskite. G.R.S.

Technical analysis of minerals and silicates, and determination of rare elements. THÜRMER. *Glashütte*, **61** [45], 833–36 (1931).—T. describes (1) the determination of minerals; (2) the quantitative analysis: (*A*) the determination of water, and (*B*) carbonic acid in minerals which may be determined in three ways: (*a*) The simplest method is possible only with pure carbonates and without volatilizing constituents. The weighed substance is heated to redness to constant weight and the difference is to be assumed as CO_2. (*b*) The substance is treated with acid in a closed flask, the carbonic acid (CO_2) is expelled, and the remainder is collected in a measuring burette (liter weight of CO_2 is 1.9763 g.). (*c*) The CO_2 gas liberated according to the second method is collected in a caustic potash solution (50% KaOH) and alkalimetrically measured. (3) Silicate analysis. Several conversions are necessary, *e.g.*, a conversion with soda for determining silica and the eventual fluorine and a second conversion for boric acid.

HCl is used for determining bases and alkalis. One gram of the substance is fused with pure soda, all the metal oxides are changed into fused carbonates, and the silica is changed into soluble alkali silicate. Materials rich in alumina are fused with a mixture of soda and borax. Metals are determined in one treatment with hydrofluoric and sulphuric acids to obtain large quantities of silica. Alkalis may be determined also by treating with ammonium chloride-calcium carbonate. After collecting the residue with dilute acid, the analysis is continued by separating the noble metals, sulphoacids, and heavy metals. The acid filtrate is liberated from H_2S by boiling. If chromates are present, it is boiled to dryness, treated with HCl, and reduced with alcohol. The hot hydrochloric solution is treated with ammonium chloride and Fe, Cr, and Al are precipitated from the hydroxides with ammonia free from carbonates; Ti, Zr, U, Be, Th, and Ce are also precipitated if present. The sediment is washed with water containing ammonia and the filter is treated with 10% cold ammonium carbonate solution, shaken, and left to stand. Zirconium and uranium go into solution as they were precipitated in the filtrate. Zirconic acid is completely precipitated by short boiling, filtering off, calcining, and weighing as ZrO_2. Uranium is precipitated by adding ammonia, boiling, filtering, calcining, and weighing as U_3O_8. If beryllium is present, the remaining ammonia sediment is boiled with a 10% potassium carbonate solution, and the beryllium and alumina hydroxide are dissolved. Alumina is again precipitated by salting out with ammonium chloride or carbonate, filtered, and weighed. Beryllium is precipitated with ammonia and determined as BeO. If Th and Ce are present, the filter residue of the ammonia deposit is dissolved in HNO_3 and steamed to dryness in a water bath. Th and Ce in the watery extract are precipitated with a 10% oxalic acid solution and filtered off. The washed precipitate is extracted with hot saturated ammonium oxalate solution; thorium oxalate goes into solution and is precipitated from it by boiling with HCl or treating it with ammonia. The deposit is calcined and weighed as ThO. Cerium is also determined as an oxide. The undissolved remaining filter residue containing Ti, Fe, Cr, and Al (when not dissolved by potash in the presence of Be) is further treated according to usual methods. The filtrate is used for the precipitation of ammonium sulphate and the determination of alkaline earth and magnesium. Sulphur may be determined according to Eschka. The substance is mixed with a mixture of 2 parts of magnesia and 1 part soda and is carefully calcined. The cold mixture is boiled with water, oxidized by means of bromine water, filtered, and acidified with HCl. The sulphur present as sulphate is precipitated with barium chloride. SO_3 and S in silicates are determined with soda after acidifying and separating silica with $BaCl_2$ also. Barium and calcium, in the presence of lead, are treated in the following way: the elements are converted into sulphates and treated with hot water; $BaSO_4$ and $CaSO_4 + PbSO_4$ are filtered; the lead sulphate is dissolved with ammonium acetate, precipitated with ammonium sulphate, and specially determined; then the calcium sulphate is treated with HCl and precipitated as calcium oxalate. The calcium oxalate filtered off is dissolved in dilute sulphuric acid, and the liberated oxalic acid is titrated with 10% normal $KMnO_4$ (1 cc. = 0.0028 g. CaO). $BaSO_4$ remains undissolved and is calcined or dried and weighed. For the determination of Fe" and Fe"', a decomposition in an atmosphere closed from air should be made. (Silicates should be treated with hydrofluoric acid in a stream of carbonic acid, and the platinum crucible must be put into a lead container.) The FeO content is ascertained by titrating with $KMnO_4$ (n/10 cc. = 0.007184 g. FeO); the total iron value (1 cc. = 0.005584 g.) is determined after reducing with tin in a "valve flask," and the difference is calculated as Fe_2O_3. (4) Analyses of minerals with rare earths. The substance is powdered, repeatedly evaporated with sulphuric acid and nitric acid, and dissolved with water. SiO_2, PO_4, Nb, and Ta remain in the residue. It is evaporated with HF, calcined,

and SiO_2 is determined as the difference; the remaining residue is treated with $KHSO_4$ and dissolved with dilute sulphuric acid. Phosphoric acid in the solution is determined in a known method, and the undissolved residue of niobium (columbium) and tantalum is filtered off and fused with soda. The melt is digested with water and treated with carbonic acid without considering the somewhat insoluble tantalic acid remaining after the addition of sodium carbonate; the $Ta(OH)_5$ is separated into flakes, filtered, and determined. Niobic acid is precipitated in the filtrate by introducing SiO_2. Th, Ce, La, Di, Y, Er, Al, Fe, Ca, Mg, Be, Na, Zr, and U can be present in the original solution. H_2S is introduced, the sediment appearing is filtered off, and the filtrate is boiled and evaporated to dryness. The residue is treated with a little water and 40 to 50 cc. of boiling 10% oxalic acid solution are added. The filtrate is separated from the sediment (Th, La, Ce, Di, Y, Er). The washed sediment is extracted with a hot saturated solution of ammonium oxalate, and thorium oxalate goes into solution from which it is precipitated by boiling with HCl or treating with ammonia; it is filtered, calcined, and weighed as thorium oxide (ThO_2). The residue is slightly calcined, dissolved with a little nitric acid, decolorized with several drops of alcohol ($Ce^{\cdot\cdot\cdot\cdot}$ in $Ce^{\cdot\cdot\cdot}$), evaporated to dryness, and treated with a little water; some solid pulverized K_2SO_4 is introduced into the solution. After a short boiling, it is left to stand and the precipitate of Ce, La, and Di is filtered. It is treated with dilute HCl, precipitated with oxalic acid, and heated to redness, and the oxides are again dissolved in HCl. A surplus of NaOH and 1 or 2 cc. of liquid bromine are added; it is shaken and filtered. (The shaking with bromine may be avoided when the qualitative detection of cerium with acetic "benzidine" (blue coloring) suffices.) The $Ce(OH)_4$ sediment is dissolved in a little nitric acid, diluted, and again precipitated with ammonia as a brown precipitate; it is calcined and the CeO_2 is weighed. The solution contains La and Di; it is acidified with hydrochloric acid, the bromine is boiled down, and the elements are precipitated with oxalic acid, calcined, and weighed as oxides. Didymium in the spectroscope is qualitatively ascertained together with lanthanum after dissolving in ammonium acetate, through the characteristic blue coloring with ammonia. The filtrate of K_2SO_4 precipitation contains Y and Er. It is precipitated with oxalic acid, calcined, and weighed, and the oxides are dissolved in nitric acid. It is evaporated to dryness and treated again with a little water. Erbium is tested in the spectroscope and yttrium is tested with HF in a platinum vessel (precipitation of white YF_3). The filtrate of the first oxalic acid precipitate contains Al, Fe, Ca, Mg, Be, and Na in addition to Zr and U. They are separated into 2 groups by precipitating with ammonia and identified and determined as described above. (5) Separation of alkalis. The results of alkali determination and separation of potassium and sodium are made more difficult by the presence of lithium in many kinds of feldspar. Lithium may be tested spectroscopically with an ether-alcohol mixture or by means of flame decoloration. Indirectly, lithium may be determined quantitatively from the total alkali chlorides through absorption with amyl alcohol in which the chlorides of potassium and sodium are insoluble, but LiCl is soluble. M.V.K.

Treating silicates containing alumina. A. THÜRMER. *Keramos*, **10** [25–26], 657–60 (1931).—Different methods for treating silicates containing alumina are discussed. Only three were found practicable. (1) In the soda treatment, by decomposing the substance to be analyzed with sodium carbonate, the silica is converted into soluble alkali silicate. It is unnecessary to use a mixture of sodium and potassium carbonate. The melt is digested with distilled water to a complete dispersion and put into a porcelain or glass dish, covered with a watch glass and carefully acidified with concentrated hydrochloric acid, steamed to dryness in a water bath, and, after cooling, moistened with concentrated hydrochloric acid, treated with hot water, and filtered.

The filtrate is boiled down, dried for 1 hr. at 120°, again treated as previously, and filtered. Silica is completely free from water after calcining. A rectification is made for the control by evaporating to dryness with hydrochloric acid. The residue consists mainly of TiO_2, Fe_2O_3, some MgO and Al_2O_3, and P_2O_5. It must be treated again with soda to obtain an exact and complete analysis. The silica determination undergoes some variations when fluorine and boric acid are present simultaneously. The separation of silica by means of a membrane filter greatly shortens the analysis. The melt sample is digested in water, acidified with hydrochloric acid, and, after resting, is filtered through a membrane filter without previous steaming. (2) The treatment with hydrochloric and sulphuric acids is necessary when analyzing larger quantities of silica. The substance is treated with about 25 cc. of chemically pure 40% hydrochloric acid, evaporated in a water bath, and evaporated 2 or 3 times with several drops of hydrochloric acid. After this evaporation, the fluorides are converted into sulphates with sulphuric acid. The surplus of sulphuric acid is evaporated in the air bath. The residue is treated with dilute HCl and boiled till the solution becomes clear. The presence of silicates containing alumina greatly complicates the soda and hydrofluoric methods. (3) The best method is the borax treatment. The platinum crucible is half filled with borax and slowly heated; the melted borax must cover the walls of the crucible. After cooling, the substance to be investigated is put into the crucible and heated till the molten mass becomes clear and homogeneous. After this, the melt is dissolved out with water, acidified, and further treated. Investigations showed that the boric acid does not affect the determination of other ions, especially of alumina. No traces of boron were found in the calcined alumina deposit. The microscopical testing of silicates containing alumina is efficient because it shows not only the structure and origin of the material but also the composition and the best method for treating it. M.V.K.

Separation of alkalis and silicates and volumetric determination of potassium. P. N. GRIGORIEV AND S. S. KOROL. *Zhur. Khim. Prom.*, **8** [1], 68–70 (1931); *Chim. & ind.*, **26** [6], 1302 (1931).—The determination of alkalis and especially those of potassium is difficult. One of the best methods used is that of cobaltohexanitrite, although the separation of alkaline metals is very slow. This method is simplified and explained. M.V.K.

Coördination number of aluminium in the alumino-silicates. J. S. HEY AND W. H. TAYLOR. *Z. Krist.*, **80** [5–6], 428–41 (1931).—After reinvestigating the sillimanite and andalusite structures, it is concluded that the coördination number of aluminium has the value 4, 5, or 6 in the three forms of Al_2SiO_5. In cyanite the O atoms are all close-packed and every Al atom is surrounded by 6 O atoms which form an approximately octahedral group. Corresponding to the coördination number 6, the distance from Al to O is about 1.9 Å. In sillimanite, one-half the Al atoms are within octahedra which are nearly regular in shape and only slightly bigger than the (SiO_4)-tetrahedron; when the coördination number of Al is 4, the interatomic distance is diminished from 1.9 Å to about 1.7 Å. This fact is of particular interest because in many silicates of variable composition Al and Si behave as equivalent atoms, and the distance from Si to O is about 1.6 Å, only slightly less than the interatomic distance for four-coördinated Al atoms, with a corresponding adjustment of environment of the adjacent O atoms. It is believed that the coördination number is actually 5 in andalusite. G.R.S.

Analysis of siliceous-aluminous-calcareous-alkaline materials. JULES DEFORGE. *Rev. belge ind. verrières*, **2**, 173–75, 197–99 (1931); see also *Ceram. Abs.*, **11** [1], 58 (1932). A.J.M.

Analysis of silico-aluminous compounds. E. DELFELD. *Bull. soc. chim. Belg.*,

40, 427–36 (1931).—Procedures to be recommended for industrial control are discussed. (*C.A.*)

Thermal decomposition of alunite. W. L. FINK, K. R. VAN HORN, AND H. A. PAZOUR. *Ind. Eng. Chem.*, **23** [11], 1248–50 (1931).—The thermal decomposition of the mineral alunite was investigated by X-ray diffraction methods and chemical analysis. R.G.M.

Determination of silica with perchloric acid. CARROLL B. CORE. *Rev. mat. constr. trav. pub.*, No. 265, p. 408 (1931); for abstract see *Ceram. Abs.*, **10** [5], 385 (1931). M.Y.H.

Quantitative determination of calcium with picrolonic acid. R. DWORZAK AND W. REICH-ROHRWIG. *Z. anal. Chem.*, **86**, 98–113 (1931); *Sprechsaal*, **65** [4], 66 (1932).—A new calcium determination is described. The substance is treated with picrolonic acid and a well crystallized calcium picrolate is obtained. It is possible to determine exactly very small quantities of Ca; this method is suitable for the separation of magnesium and calcium and for determining the lime hardness of the water. M.V.K.

Fluorspar. A. LEBRUN. *Rev. belge. ind. verrières*, **2**, 220–21 (1931).—L. discusses the methods of analyzing (chemically) fluorspar. A.J.M.

A volumetric method of determining sodium. J. T. DOBBINS AND R. M. BYRD. *Jour. Amer. Chem. Soc.*, **53** [9], 3288–91 (1931).—A rapid and accurate volumetric method of determining sodium has been developed, in which the sodium is precipitated as sodium zinc uranyl acetate, and the uranium content of the precipitate is titrated by means of sodium hydroxide. R.G.M.

Thiosulphate titrations of small amounts of iron in glass sands. LEWIS B. SKINNER. *Ind. Eng. Chem.* [Anal. Ed.], **3** [4], 411–14 (1931).—A rapid and accurate method for iron determination, using ordinary laboratory equipment, is described. Sand low in alumina is run to dryness with hydrofluoric acid in a silver dish; the residue is fused a few moments with sodium hydroxide and chlorate; the melt is disintegrated by water and transferred to a beaker; the solution is acidified by hydrochloric acid and a little nitric acid and boiled; ferric hydroxide is precipitated by an excess of ammonia, filtered off, and dissolved in a little dilute hydrochloric acid; the solution is evaporated to a small volume, potassium iodide and starch are added, and it is titrated by a standard thiosulphate. When alumina is relatively high, sodium chlorate is omitted in the fusion, the melt is disintegrated in water, sodium sulphide is added, the sulphide of iron is filtered off, dissolved, and oxidized, and ferric hydroxide is precipitated by ammonia and is treated further as shown above. R.G.M.

Separation of calcium and magnesium by the molybdate method. R. C. WILEY. *Ind. Eng. Chem.* [Anal. Ed.], **3** [2], 127–29 (1931).—Calcium molybdate is quite insoluble in a solution that is nearly neutral. Calcium may be determined accurately by precipitating as the molybdate. The presence of residual ammonium molybdate in the washings from the calcium molybdate does not prevent the precipitation of magnesium as the magnesium ammonium phosphate and the presence of ammonium salts does not interfere with the determination of calcium as molybdate. Calcium and magnesium may be determined in much less time when the molybdate method for calcium is used than when the calcium is precipitated by the oxalate method. R.G.M.

A rapid colorimetric method for the determination of potassium by the use of cobaltinitrite. E. M. EMMERT. *Jour. Assn. Official Agr. Chem.*, **14** [4], 573–75 (1931).—It was found that colormetric measurement of the change in strength of the precipitating reagent, in place of a quantitative separation of the precipitate, greatly shortened the time required for a determination. The potassium is precipitated as $K_2NaCo(NO_2)_6$ from solutions evaporated nearly to dryness and containing 0.3 to 19.00 mg. potassium by adding sodium cobaltinitrite as determined by the amount of precipitate formed

in a preliminary test. The solution is diluted to 20 cc. with sodium nitrite solution, filtered, and the filtrate compared in the colorimeter with a solution composed of the same quantities of sodium cobaltinitrite and sodium nitrite as used in the precipitation of the potassium. The sodium cobaltinitrite is prepared by dissolving 5.1666 g. pure sodium cobaltinitrite in 40 cc. distilled water. Twenty-seven grams potassium-free sodium nitrite are added dissolved in 40 cc. distilled water. Six cubic centimeters of glacial acetic acid are added and made up to 100 cc. The sodium nitrite solution is prepared by dissolving 13.5 g. potassium-free sodium nitrite in 100 cc. distilled water. Organic matter, if present in sufficient amount to interfere, may be oxidized with sodium chlorate and nitric and sulphuric acids. Ammonia and metals tending to color the solution may be removed by boiling with sodium carbonate and filtering. J.L.G.

Pyrochemical series of oxides. H. SALMANG. *Sprechsaal*, **64** [53], 994 (1931).—Homogeneous silicate melts are to be considered as solutions. Their properties, like those of solutions, cannot be studied by measuring the dependence of their physical constants on temperature; the only way is by investigating their chemical reactions. One reaction is the corrosion power of definitely composed melts on refractory materials. This was planimetrically measured. Separate oxides act differently. Generally, the oxides act very strongly although those rich in oxygen do not influence or even check the reaction. It was possible to determine numerically the value of attack of different oxides and to produce a formula in which the value of the attack expresses the quotient of the attacking and nonattacking oxides. For a ground melt composed of $2FeO \cdot SiO_2$ to which different oxides were added (at 1410° for 1 hr.), this formula reads: $K = 2.1 \times \frac{10(PbO)+8(Cu_2O)+7(BaO)+6(CaO)+5(MgO)+4(SnO)+3(FeO)+3(NiO)+2(MnO)}{(Ni_2O_3)+1.6(Al_2O_3)+1.6(SiO_2)+2.2(Fe_2O_3)+3(ZnO)+5(Sb_2O_5)+14(SnO_2)+18(Cr_2O_3)}$. The oxides are given here in mol per cent. PbO is the strongest base and MnO, the weakest; Ni_2O_3 is the weakest acid and Cr_2O_3, the strongest. TiO and P_2O_5 must be mentioned as acids. All the results showed that Al_2O_3 always reacts as an acid which is contrary to metallurgical beliefs in which it is considered amphoteric. The only amphoteric oxide observed was ZnO. Alkalis play a special rôle. They do not act as very strong bases, as would be expected from their behavior in watery solutions, but apparently as very strong acids. This can be explained by the fact that alkali silicates possess a very high heat of formation and therefore do not dissociate in the melt, while all the other silicates because of their small heat of formation dissociate thoroughly into oxides which alone can attack. A far-reaching dissociation of silicates is proved by this. The formula mentioned above can be changed into $K = \frac{\Sigma(R_2O - \text{alkalis}) + \Sigma(RO)}{\Sigma(R_2O_3) + \Sigma(RO_2) + \Sigma(R_2O_4) - \text{alkali silicates}}$. By repeating these tests at different high temperatures, it was found that the velocity of reaction increases more slowly than at ordinary temperatures. It shows that the dissociation assumes considerable values immediately after the beginning of the melting. The attack increased only about 50% with a temperature increase of 80 to 90°. The succession of oxides just mentioned can be compared with the electromotive series of metals. Like these it is also an electromotive series. This signifies that it will provide a changing valuation of the numerical factors similar to the electromotive series of metals for every oxide according to the kind of test requirement. This may lead so far in both series that a change in places of the adjacent oxides may appear. Through the measurement of the physical properties of glasses in dependence on their composition, it was found that the oxides act even in brittle glass in almost the same sequence as in the silicate melt. The melt bases lower the viscosity, increase the coefficient of expansion, and decrease the thermal conductivity, while the melt acids produce the contrary. M.V.K.

Thixotropy of bentonite suspensions. H. FREUNDLICH, O. SCHMIDT, AND G. LINDAU. *Z. physik. Chem.*, pp. 333–40 (1931).—Suspensions of finely divided bentonite settle in water if the concentration is small, whereas if the concentration is high they show thixotropic behavior. The purpose of this article was to point out some of the factors which affect this behavior. Previous experiments seemed to indicate that the stability of the suspension and the disappearance of thixotropy were dependent on the base content of the solution. When the base content was diminished by electrodialysis the thixotropy of the suspension disappeared. Accordingly these studies were outlined, whereby KOH and KCl were added to a 20% suspension of electrodialyzed bentonite. The time was then noted at which a violently shaken suspension became so hard and firm that on turning the vessel upside down it did not begin to flow. A pure aqueous suspension (one without electrolyte) of the same concentration is not thixotropic but settles after a long time. Thus thixotropy is closely related to base exchange and to the swelling of the particles on increasing base exchange. See also *Ceram. Abs.*, **9** [11], 973 (1930). L.T.B.

Some colloidal properties of bentonite suspensions. H. A. AMBROSE AND A. G. LOOMIS. *Physics*, **1**, 129–36 (1931).—Emulsoid colloids present in bentonite respond to changes in p_H of the dispersion medium by changes in rate of settling, viscosity, and swelling. The curve showing the relation between p_H and per cent sediment in a definite time has a maximum at the isoelectric point with minima on each side corresponding to points of maximum adsorption. As p_H is further increased or decreased, flocculation begins with increased rate of settling. The viscosity curve is closely related to the rate of settling. Maximum swelling occurs at approximately the point of maximum viscosity. Such salts as NaCl and KCl are markedly effective in preventing the swelling of bentonites. The gel-forming properties of bentonite may be used to prevent settling of the so-called "weighted fluids" in drilling oil wells. (*C.A.*)

Spinel structure. F. MACHATSCHKI. *Z. Krist.*, **80** [5–6], 416–27 (1931).—Employing the F-curve for the intensity calculation of the structure of the common spinels it is shown that a value is found for the parameter u of the oxygen atom whose intercept shows good agreement with the empirical ion radius determined by Goldschmidt. M. points out the great care that must be used in calculating atomic intercepts. A note follows discussing a paper by Barth and Posnjak (see *Ceram. Abs.*, **10** [12], 844 (1931)) in which M. disagrees with the conclusions drawn by B. and P. G.R.S.

Structure of some Al_2O_3-containing colors. OTTO KRAUSE AND WERNER THIEL. *Z. anorg. allgem. Chem.*, **203** [1], 120–28 (1931).—The ceramic industry requires colors which are characterized by stability and resistance to decolorization on firing as well as colors which will not be attacked by chemicals. It has been found that the most resistant colors are made by mixing a monoxide with a sesquioxide in spinel proportions, *i.e.*, in 1:1 molecular proportions. The purpose of these experiments was to determine what compounds were formed when the sesquioxide was alumina. Microscopic and X-ray studies were made. Not only were 1:1 mixtures fired but also mixtures in the proportions $1NO:1.5Al_2O_3$ and $1NO:2Al_2O_3$, where NO was ZnO, MnO, NiO, CoO, CaO, and FeO. The temperature of firing and furnace conditions were recorded. It was found that the original oxides were not nearly completely converted to spinels in commercial manufacture; but some spinel was identified in all mixtures. The edge of the unit cube of each of the pure spinels was determined and is reported. L.T.B.

Calculation of ceramic masses and vitrifying glazes. F. FRANCESCHINI. *Ind. Silicati*, **9** [7], 7–10; [8], 7–10; [10], 7–11; [11], 7–11; [12], 7–11 (1931).—Ways of making the calculations which are used by ceramists to determine pastes, glazes, coloring masses, and enamel are explained and illustrated by examples. These include the

following calculations: (*a*) ceramic masses by rational analysis and its importance and practical application, (*b*) the rational constitution of a ceramic mass, knowing the composition of the mass itself, and (*c*) the rational analysis on the basis of the chemical analysis. Other calculations of glazes, enamels, coloring substances, and similar products were as follows: (*a*) raw materials, (*b*) the Seger formula, (*c*) the Seger formula knowing the chemical analysis, (*d*) the Seger formula knowing the mix, (*e*) the mix on the basis of the Seger formula, (*f*) determination of the Seger formula from the mix of glazes, (*g*) biscuit fragments as raw material in glazes, (*h*) determination of the addition necessary to fix the soluble salts, and (*i*) additions of lime to clays and masses for majolica poor in lime. M.V.K.

Researches on kaolins and clays. GUSTAV KEPPELER AND HANS GOTTHARD. *Sprechsaal*, **64** [47], 863–66; [48], 883–87; [49], 908–16; [50], 929–32; [51], 947–50; [52], 968–71 (1931).—(1) Clay substance and mica are decomposed when using the sulphuric acid treatment in the rational analysis, and only the clay substance is decomposed when using the Kallauner and Matějka method of heating to redness. Through the combination of both methods, it was possible to measure the mica content of the clays. The difference between the clay substance plus mica produced by the sulphuric acid treatment and the clay substance resulting from the calcining analysis of Kallauner and Matějka is called mica. Mica is therefore a collective term for all constituents which are decomposed by sulphuric acid but not by the calcining analysis. Many clays therefore have a high mica content, *e.g.*, 82% mica to 100 clay substance was the highest amount found in the clays investigated. Besides the main constituent clay substances, mica, quartz, and feldspar, which can be determined by the rational analysis, the secondary ingredients, *i.e.*, salts soluble in water and organic impurities present in certain clays, have the greatest influence on the behavior of clays. (2) The results from the determination of concentrations of hydrogen ions show that when comparing the p_H value of a clay with its dispersion in a watery suspension, it is found that all clay and kaolin suspensions which have a neutral or alkaline reaction are dispersed. To explain the different behavior of acid-reacting clay suspensions, the content in alkali soluble humus must be taken into consideration. A table shows the dependence of the dispersion of clays on the concentration of hydrogen ions and the humus content. Among the acid-reacting clays, only those are dispersed which contain a considerable amount of alkali-soluble humus substance. (3) The determination of the smallest fractions is important in order to characterize clays on the basis of the distribution of the sizes of particles. The analysis by elutriation and the determination by means of Wiegner's method (precipitating pipe) do not give satisfactory results. The measurement of the size of particles of clays by means of the pipette method permits their measurement up to a degree of fineness of about 0.1μ. Kaolins and kaolin clays (thin clays) are considerably more coarse-grained than plastic clays. The first contain a surface factor which is smaller throughout than 2.5 sq. m. per 1 g.; the latter, a surface factor which is larger than 2.5 sq. m. (4) A measure for the degree of dispersion is obtained by coloring clays with methylene blue and by determining their hydroscopicity. The values obtained by these indirect methods agree only roughly with those obtained by the pipette analyses because of the changing composition of the different clays. These values, however, are in close relationship with the plasticity. (5) The plasticity was determined according to the method of Rosanow. It was found that the product of the water content, dilatation, and bending strength obtains a maximum value for every clay with a certain water content. This optimum cannot be reached in thinner materials because their stability is too low. The maximum value is called "figure of plasticity." The fineness of particles exerts a considerable influence on the figure of plasticity. (6) It was found from liquefaction tests that thin materials

rich in alkali-soluble humus substance are especially well liquefied by additions of caustic soda solution. Fat kaolins and clays rich in humus and thin kaolins and clays free from humus are poorly liquefied by alkalis alone. The great number of clays investigated confirms the results of the researches of Spangenberg. Alkali soluble humus may stop the flaking action of an alkali surplus to a certain degree. (7) The separate secondary ingredients of clays exert an influence on the behavior of clays during firing. Firing tests with clay samples show that the mica and quartz content are decisive for the stability during firing besides the fineness of particles. The more fine-grained the clay substance is, the more stable is the material; and the more fine-grained the mica is, the less stable the material is. The capability of shrinking depends on the quartz content and the fineness of particles. The finer the material, the larger the shrinkage is; the larger the quartz content, the less shrinkage occurs. Porosity depends on the quartz and mica contents and the size of particles. The cone fusing points of clays depend on the quartz and mica content: 10% mica lowers the fusing cone $^1/_2$ number; 45%, 3 to 4 numbers. M.V.K.

Studies on the liquefaction of kaolin and clay by alkalis. A. LOTTERMOSER AND EDMUND SCHMIDL. *Z. anorg. allgem. Chem.*, **203** [1], 129–45 (1931).—In the ceramic industry "pouring" of the clay is resorted to frequently. By this procedure it is possible to mix the clay to a thin, fluid mush by the use of a very small amount of water, provided that soda is added also. A study was made of this behavior. The liquefaction of various kaolins and clays on using sodium and potassium hydroxides, carbonates, and silicates was followed by viscosity measurements. The viscosity of the mush decreases with time. The viscosity of the neutral clay is greatly affected by the particle size, but the particle size does not seem to affect the viscosity of a clay to which alkali has been added. Ca^{++} content is harmful from the standpoint of easy liquefaction; humus acids are beneficial. Tables of results are given in detail with the optimum conditions for liquefaction. L.T.B.

Equilibrium in the iron–oxygen–hydrogen system at temperatures above 1000°C. W. E. JOMINY AND D. W. MURPHY. *Ind. Eng. Chem.*, **23** [4], 384–87 (1931). R.G.M.

Grading aggregates. I. Mathematical relations for beds of broken solids of maximum density. C. C. FURNAS. *Ind. Eng. Chem.*, **23** [9], 1052–58 (1931).—Equations for the grading of broken solids are set up to give beds of maximum density. A consideration of the voids in a bed of the coarsest particles leads to two types of solution: the one for intermittent grading and the other for continuous grading. Theoretically, the first should give the best packing, provided suitable means of practical application are developed. An example is given of the method of calculating sizes to be used for the intermittent grading. The second solution gives a system which has probable advantages of workability and its grading can be more or less closely approximated using commercial materials. The solution of the first equation is made and given graphically and the results so obtained have been used in plotting curves for the minimum possible voids on mixing 2, 3, or 4 sizes of materials. The method of solution of the equation for continuous grading is indicated. No single curve for continuous grading is sufficient for all systems. The type of curve for maximum packing is determined by (1) voids in a bed of normally packed, sized material, and (2) the ratio of the size limits of the system. **II. Application of mathematical formulas to mortars.** F. O. ANDEREGG. *Ibid.*, **23** [9], 1058–64 (1931).—Of the two types of grading, *i.e.*, intermittent and continuous, that for continuously graded aggregate gives best results in mortars, including masonry, stucco, and cast stone mixes, because of the remarkable workability combined with good packing. The intermittent or gap grading when modified slightly to improve workability and when carefully applied

gives good results and is being successfully applied commercially in making certain concrete products. R.G.M.

Ultrasonic measurements of the compressibility of solutions and of solid particles in suspension. CHESTER R. RANDALL. R. P. 402; Bur. Stand., *Jour. Research*, **8** [1], 79–99 (1932).—Ultrasonic interferometer apparatus and a method of measuring ultrasonic velocities in liquids are described. Results of ultrasonic measurements on distilled water at temperatures 0 to 86°C and on aqueous solutions of four kinds of sugar for several concentrations and a series of temperatures are presented in curves and tables. The compressibility of distilled water and of the solutions is determined from ultrasonic velocity measurements. Pyrex glass suspensions (aqueous) were prepared, the Pyrex particles ranging in size from two microns down. Ultrasonic velocity measurements were made on these suspensions for the purpose of testing the possibilities of a theory for getting the compressibility of a solid by a velocity-suspension method. The results obtained, though largely qualitative, show possibilities and limitations of method. R.A.H.

Quantum dynamical correction for the equation of state of gases. HENRY MORGENAU. *Proc. Nat. Acad. Sci.*, **18** [1], 56–62 (1932). J.L.G.

Measurement of velocity of hydrolysis of aqueous solutions of water glasses. L. WASILEWSKI AND W. BADZYNSKI. *Przemysl Chem.*, **15**, 185–88 (1931).—Glasses with $SiO_2:Na_2O$ = 2.9, 3.5, 4.2, and 5.3, melted at 1200, 1300, 1400, and 1500°, indicate that with high $SiO_2:Na_2O$ it is hard to produce a slowly hydrolyzing water glass, and *vice versa*. Data point out that glasses melted at higher temperatures show the greatest ability to hydrolyze. There is uncertainty as to the velocity of hydrolysis of some glasses. The method consisted of covering with 8 cc. of a given glass $^1/_2$ of a test tube of granulated limestone, keeping the sample at 100° for 60 min. and finally centrifuging for 5 min. in calibrated test tubes. The volume of the precipitate in 0.1 cc. shows the velocity of hydrolysis. The whole series of samples was run at once. Water glasses showing a hydrolysis velocity less than 10 correspond to those which under proper conditions of silicating should give good results with road materials in the field. (*C.A.*)

Heats of wetting and of adsorption on zinc oxide. W. W. EWING. *Ind. Eng. Chem.*, **23** [4], 427–29 (1931). R.G.M.

Explicit formulas for slip and fluidity. MELVIN MOONEY. *Jour. Rheol.*, **2** [2], 210–22 (1931).—Formulas for both slip and fluidity are developed as explicit functions of experimental quantities directly determined with capillary or rotating cylinder viscometers. The general expression for the kinetic energy correction to the pressure in the capillary viscometer is given in terms of the fluidity and slip functions. As an illustrative example some data are analyzed which indicate the presence of both slip and variable fluidity. G.R.S.

Determining surface moisture. ANON. *Laboratory*, **4**, 74–75 (1931).—A measured volume of the material to be tested is mixed with an equal volume of saturated salt solution. The moisture is taken up by the salt solution, and the change in density read off on a hydrometer. H.H.S.

Determination of the true lime value in raw mix, etc. DONALD C. PAQUET. *Rock Prod.*, **35** [3], 60 (1932).—P. found that the CaO values obtained from analyses of raw mix or similar materials, using the sodium carbonate fusion method, varied with the amount of sodium carbonate used. He outlines a method of analysis in which this fusion is not used, thereby eliminating the error involved. The method is precise and rapid and parallels to some extent the standard method of the A.S.T.M. for limestone analyses. W.W.M.

Measuring the permeability of tile. ANON. *Brit. Clayworker*, **40** [477], 366

(1932).—A simple and ingenious method of measuring the permeability of tile has been devised by Hans Hirsch. A piece of tile is cut roughly to form a disk 4 in. in diameter and this is cemented into a glass funnel with plasticine, wax, or other suitable cement. Care must be taken to make the joint between the sample and funnel air-tight. A second funnel is connected to the first (tops together) and also to a current of air under a constant but small pressure, and the air which passes through the sample is collected in a gas-jar by means of a pneumatic trough. The pressure required to give a measurable amount of air varies with the samples, but it need not usually exceed 6-in. water gage. The volume of air in the gas-jar is measured and the permeability is expressed in terms of cubic centimeters of air passed in an hour per square centimeter of tile surface. R.A.H.

Further studies on the relationship between the fine material of soils and their physical characteristics. G. J. BOUYOUCOS. *Soil Sci.*, **33** [1], 27–39 (1932).—A study was made to ascertain whether there are close relationships between the "total colloids," clay, and fine clay of soils, as determined by the hydrometer method, and certain consistencies of soils such as the crumbling point, flow point, and upper plastic limit. If such close relationships exist, then the consistencies and other soil physical properties can be indirectly determined quickly and simply and probably more accurately by means of the hydrometer method. From the results obtained coefficients of correlation were worked out, and these in turn were reduced to the percentage basis. The coefficients of correlation on the soils worked show that the variability of the crumbling point is controlled 93.3% by the "total colloids," 88.93% by the clay, and 85.0% by the fine clay. The variability of the flowing point is controlled 84.8% by the "total colloids," 82.1% by the clay, and 83.7% by the fine clay. The variability of the upper plastic limit is controlled 83.9% by the "total colloids," 83.5% by the clay, and 84.6% by the fine clay. The variability of the moisture equivalent is influenced 82.7% by the "total colloids," 80.1% by the clay, and 80.5% by the fine clay. No definite relationship could be established between the chemical composition of the fine material of soils studied and their physical properties. From the correlations obtained it would seem that the hydrometer method can be employed to obtain indirectly and quickly certain physical characteristics of soils. G.R.S.

Studies on the dispersion procedure used in the hydrometer method for making mechanical analysis of soils. G. J. BOUYOUCOS. *Soil Sci.*, **33** [1], 19–26 (1932).—The hydrometer method of making mechanical analyses of soils was further investigated by comparing its mechanical stirrer with the standard shaker for dispersing soils. It was found that the 10 min. stirring with the mechanical stirrer produced about the same degree of dispersion as 16 hours' shaking with the standard shaker. Treating soils with H_2O_2 did not affect their mechanical analysis as measured by the hydrometer method except in soils that contain very large amounts of organic matter, especially of the undecomposed type. On account of its efficiency, the mechanical stirrer tends to break down the sand particles on long stirring; hence it is advisable not to stir the sandy soils too long. The extreme rapidity with which the hydrometer method is able to measure the mechanical analysis of soils is not due to their incomplete dispersion. Further research and comparison tend to support the original findings that the hydrometer method is reasonably accurate and reliable. G.R.S.

Laws of soil colloidal behavior. VII. Proteins and proteinated complexes. SANTE MATTSON. *Soil Sci.*, **33** [1], 41–71 (1932).—This paper deals with the electrokinetic and chemical behavior of aluminum- and ferric-"proteinates" and of protein-"humates," "bentonates," and "silicates." The proteins studied include albumin, casein, edestin, and gelatin. The complex formation between the proteins on the one side and the positive and negative silver chloride and barium sulphate on the other has also been

studied and discussed. The fundamental principles previously established in the case of the silicated, phosphated, and humated compounds of the sesquioxides were found to apply to all the complexes described in this paper and have thus been generalized. For Part VI see *Ceram. Abs.*, **11** [2], 135 (1932). G.R.S.

Proposed changes in calculation of norms of rocks. T. F. W. BARTH. *Mineralog. petrog. Mitt.*, **42** [1], 1–7 (1931).—It is proposed that the following normative pyroxene minerals be used: $CaSiO_3$, $MgSiO_3$, and $FeSiO_3$ (with symbols "wo," "en," and "hy," respectively); and that the olivine molecule be given in terms of $MgSiO_4$ and Fe_2SiO_4 (with symbols "fo" and "fa"). It is shown that these changes will improve the norm by bringing the ferro-magnesian minerals into closer approach to natural conditions by making it easier to survey their composition and by rendering calculations more simple. G.R.S.

A weight per cent/mol per cent nomograph. HERBERT WATERMAN. *Ind. Eng. Chem.*, **23** [7], 803 (1931).—The calculations incidental to the construction of thermal diagrams in metallography and phase-rule work are laborious. W. presents a nomographic chart which facilitates the transformation mol per cent/weight per cent for any binary system. This nomograph may also be used for similar transformations in ternary systems. R.G.M.

Data. IV. T. W. GARVE. *Clay-Worker*, **97** [1], 40–41 (1932).—The data presented in this instalment include information on heat transmission explaining the three methods of conduction, convection, and radiation. Linear expansion, coefficient of linear expansion, and the two common scales used in thermometry are also taken up. For Part III see *Ceram. Abs.*, **11** [3], 210 (1932). E.J.V.

Application of physics in ceramics. A. V. BLEININGER. *Physics*, **1**, 268–70 (1931). (*C.A.*)

BOOKS AND BULLETINS

Röntgen Spectroscopy and Crystal Structure Analysis. (Röntgenspektroskopie und Kristallstrukturanalysis.) A. SCHLEEDE AND E. SCHNEIDER. Walter de Gruyter and Co., Berlin and Leipzig. Vol. I, viii + 336 pp. Price 18.50 Rm., bound 20.; Vol. II, iv + 344 pp. Price 22.50 Rm., bound 24. Reviewed in *Z. Krist.*, **77** [5–6], 517–18 (1931).—The chapters are as follows: (1) introduction and basis for Röntgen spectroscopy and crystal structure, (2) production, detection, and intensity estimation of X-rays, (3) spectroscopy of X-rays, (4) experimental methods of crystal structure analysis, (5) point groups (crystal classes) and space groups, (6) waves and interference, (7) crystal structure analysis, and (8) physico-mathematical supplement. The book is profusely illustrated. G.R.S.

The Sorption of Gases and Vapors by Solids. J. W. MCBAIN. G. Routledge and Sons, London. 577 pp. Reviewed in *Chem. News*, **143** [3741], 418–19 (1931).—This treatise is the first complete survey of this subject which touches closely upon fundamental theories and also finds innumerable applications in the arts and in industry. A detailed index is given with about 1500 authors who have published papers in this field. There is also a list of all the materials which have been used experimentally in studying sorption phenomena. G.R.S.

Practical Microscopy. L. C. MARTIN AND B. K. JOHNSON. Blackie and Son, Ltd., London. 116 pp. Reviewed in *Chem. News*, **144** [3742], 14 (1932).—The volume is intended to enable the reader to apply in practice the technique of modern microscopy and to this end a chapter on ultra-violet microscopy is added. Optical principles are laid down in an easy fashion enabling the microscopist to utilize his instrument to better effect. The book is well illustrated with diagrams and photographs. G.R.S.

Mechanics, Hydraulics, and Thermodynamics. (Mécanique, hydraulique, thermodynamique.) G. DARIÈS. 3rd ed. Prepared by G. Delmotte. 764 pp., 373 figures. Published by Dunod, Paris. Reviewed in *Chaleur ind.*, **12**, 447 (1931). A.J.M.

Course in Physics. Vol. II. (Cours de Physique.) CHARLES FABRY. 660 pp., 339 figures. Published by Gauthier-Villars, Paris. Reviewed in *Chaleur ind.*, **12**, 689 (1931). A.J.M.

Chemical Analysis of Rocks. H. S. WASHINGTON. 4th ed. John Wiley and Sons., Inc., New York, 1930. xvi + 296 pp. Reviewed in *Jour. Geol.*, **39** [6], 606–607 (1931). G.R.S.

Colloid Chemistry. Vol. III. Technical Applications. JEROME ALEXANDER. Reviewed in *Chem. News*, **143** [3741], 418 (1931); for review see *Ceram. Abs.*, **11** [3], 212 (1932). G.R.S.

Summary of the literature on the compounds of silicon. I. F. PONOMAREV. *Trans. Siberian Inst. Bldg. Materials*, **2**, 80 pp. (1931).—This work is the continuation of two former works published in 1914 in the *Journal of the Russian Physico-Chemical Society*, and in 1924 in the *Abstracts* of the Russian Experimental Institute of Silicates, No. 9, and is a review of the world literature for 1914, 1915, 1916, and 1917 on the compounds of silicon. P. treats (1) the theory of silicon, (2) its chemistry, (3) silicon compounds found in nature, and (4) silicon compounds used in industries, *i.e.*, (*a*) cement, (*b*) ceramics and refractory materials, (*c*) glass and enamels, (*d*) slag and silicides, and (*e*) zeolites. See also *Ceram. Abs.*, **10** [5], 384 (1931). M.V.K.

Grain size and fineness. A. H. M. ANDREASEN. *New Internat. Assn. Test. Materials*, 6 pp. (Sept., 1931).—The term "sorting value" is suggested for the grain size at which a sieve separates. Its ratio to the size of mesh for ordinary substances is 0.8 to 0.9. A single number is insufficient to characterize the fineness of materials consisting of particles of different sizes, and a curve such as the distribution curve must be used. (*B.C.A.*)

Size determination of free grains. H. W. GONELL. *New Internat. Assn. Test. Materials*, 11 pp. (Sept., 1931).—A bolting apparatus suitable for grading particles of sizes from 60μ to 2 to 10μ according to specific gravity is described. (*B.C.A.*)

Particle size of pulverulent materials. L. R. FERET. *New Internat. Assn. Test. Materials*, 9 pp. (Sept., 1931).—The "mean width" of a particle is defined as the mean for a sufficient number of particles of the distances between two tangents on opposite sides of the apparent outline of the particle parallel to an arbitrary fixed direction. The whole range of granular and pulverulent materials is classified by limiting values of the mean widths of the various classes. (*B.C.A.*)

PATENTS

Production of hydrated chromic chloride. JOHANNES BRODE AND CARL WURSTER. U. S. 1,842,535, Jan. 26, 1932.

Method of manufacturing titanic hydroxide. RALPH J. MCINERNY, EUGENE F. WILLIAMS, AND HERBERT L. GLAZE. U. S. 1,842,620, Jan. 26, 1932.

Production of alumina and alkali phosphates. CHEMISCHE WERKE VORM. H. & E. ALBERT. Brit. 363,909, Jan. 6, 1932.

Process for the manufacture of chromates and dichromates. BOZEL-MALETRA (SOC. INDUSTRIELLE DE PRODUITS CHIMIQUES). Brit. 364,361, Jan. 13, 1932.

General

Prevention of silica scale with sodium aluminate. C. H. CHRISTMAN, J. A. HOLMES, AND H. THOMPSON. *Ind. Eng. Chem.*, **23** [6], 637–46 (1931).—Silicate scale in boilers has caused loss from blistered tubes as well as heat losses from reduced heat transfer. Silica reduction in external softening may be improved by using sodium aluminate as the coagulant. Sufficient soluble alumina in boiler feed water will effect silica precipi-

tation in boilers as calcium or magnesium alumino-silicate. This material is flocculent and permits reduction of soluble silica in boiler water to a minimum. With sodium aluminate treatment silicate scale is prevented through removal of silica together with the hardness, rather than by removal of hardness alone. An experimental boiler duplicating plant operating conditions at high pressures is described. This is used for determination of reactions of silica in boiler waters. Data from actual plant operation are included. R.G.M.

Seventeen foot candle illumination without local lighting. W. A. COULTER. *Maintenance Eng.*, **90** [1], 31–34 (1932).—By the use of large units installed in porcelain steel reflectors near the ceiling, a large aeroplane factory is lighted to give an average intensity of 17 foot candles on a working plane 30 in. from the floor. Illustrated. J.L.G.

Power analysis in high-speed group drives. ROBERT W. DRAKE. *Maintenance Eng.*, **90** [1], 18–21 (1932).—D. analyzes the power losses in high-speed group shaft drives and compares them with corresponding losses in low-speed group drives. They are not much in excess of losses for low-speed drives when the driven machines are operated at high speeds. At medium speeds, they may even be less. J.L.G.

Evaporation of water by hot, dry air. R. H. NEWTON AND T. C. LLOYD. *Ind. Eng. Chem.*, **23** [5], 530–32 (1931). R.G.M.

Planned counter-offensives against fire. E. B. ADAMS AND F. W. BUCK. *Maintenance Eng.*, **90** [1], 1–4 (1932).—The measures taken to prevent and control fires in the Point Barrow Plant of the Western Electric Co., Baltimore, Md., are described. The four requisites of adequate fire protection are (1) complete protection, *i.e.*, all space covered, (2) accessibility and adequate control, (3) entire independence of any domestic water service, and (4) absolute reliability at all times. Illustrated. J.L.G.

Blasting of clay, loam, and gravel. ANON. *Tonind.-Ztg.*, **55** [103], 1428–30 (1931).—Different methods of blasting clay, loam, and gravel are described. The costs of blasting are compared with the costs of hand mining. It is found that the blasting expenses amount only to 45% of the hand-mining costs. W.M.C.

Using glass and porcelain for streets. ANON. *Keramos*, **10** [25–26], 660 (1931).—Tests with additions of glass and powdered porcelain to cement for covering streets proved to be successful. The resistance to pressure and to attrition was doubled in comparison with ordinary concrete, and the mass was more elastic. M.V.K.

Methods for the prevention of silicosis. E. A. ELSBY. *Pottery Gaz.*, **57** [656], 217–19 (1932).—Silicosis is caused by dust particles of a size of 2 microns, a considerable amount of which can be found in the fines of silica dust used in the pottery industry. Work done by different investigators on dust determinations is described and it is pointed out that efforts must be directed toward preventing a certain dustiness which, worked out in terms of 100% silica, would be three million particles per cubic foot. Dust-extraction appliances, exhaust hoods, and dust-collection plants are discussed. E. suggests that investigations be attempted in the direction of testing the possibility of using a silica powder in the pottery trade containing less "fines" than that which is used at the present time. A guarantee of certain antidustiness in installing dust-collecting plants should also be stipulated. E.J.V.

Economics of the nonmetallic mineral industries. XII. Water and motor truck transportation. RAYMOND B. LADOO. *Rock Prod.*, **35** [3], 48–49 (1932).—L. discusses the many changes which have taken place in the transportation of bulk commodities and the greater use of water transportation combined with truck haulage which has been made possible by the development of inland waterways and good roads. Long truck shipments are now common and have helped to equalize and lower prices. L. also points out that buying habits have been changed and "hand-to-mouth" buying increased. W.W.M.

Relation of the U. S. Bureau of Mines to the nonmetallic industries. ANON. *Rock Prod.*, **35** [3], 38–43 (1932).—A review of the Bureau work as applied to the nonmetallic industries is given. W.W.M.

Program for whiteware manufacturer. CHARLES F. BINNS. *Ceram. Ind.*, **18** [2], 98 (1932).—B. suggests the following lines of study which the whiteware manufacturer might profitably follow: (1) Research on body fluxes: (*a*) possibility of new and more satisfactory fluxes being found and the effect of different types of feldspar on body characteristics; (*b*) possibility of developing colored bodies by the use of different fluxes. (2) Research in testing processes: (*a*) an improved test for resistance to mechanical shock; (*b*) improved test for resistance to abrasion. (3) Glaze research: (*a*) the study of the qualities as applied to glaze distinct from glass and a study of glaze properties as influenced by body composition. W.W.M.

Rise of air conditioning. W. L. FLEISHER. *Ind. Eng. Chem.*, **23** [7], 732–35 (1931).—F. reviews the history of air conditioning and presents a survey of present-day uses. R.G.M.

Opportunities in plant research. PAUL E. COX. *Ceram. Ind.*, **18** [2], 89 (1932).—C. states that no school has the real facilities for the solution of many problems that a reasonably well built and organized factory possesses. Cases of researches on commercial plant scales are cited. W.W.M.

Scope of research management. C. E. K. MEES. *Ind. Eng. Chem.*, **24** [1], 65–66 (1932). R.G.M

Principles of research laboratory management. G. W. THOMPSON. *Ind. Eng. Chem.*, **24** [1], 68–71 (1932). R.G.M.

Logical divisions of a research organization. F. C. FRARY. *Ind. Eng. Chem.*, **24** [1], 67–68 (1932). R.G.M.

Value of proper accounting records. J. W. MILLER. *Ceram. Age*, **18** [2], 81–83 (1931).—M. describes two simple office records suitable for use in a refractories plant. R.G.M.

Range finder of business: the glasshouse cost accountant. WILLIAM A. FAWCETT. *Glass Ind.*, **13** [2], 29 (1932).—Cost accounting shows up the leaks and points the way to profits. The duties and possibilities of a good glasshouse accountant in aiding the profitable operation of a glass plant are enumerated. E.J.V.

Greetings. ECKARDT V. ESKESEN. *Bull. Amer. Ceram. Soc.*, **11** [2], 23–24 (1932).—Briefly summarizing the conditions passed through during 1931, E. offers greetings to members with hope of improved conditions in 1932. E.J.V.

Tough going. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **11** [2], 24–25 (1932).—The need for a readjustment brought about by present conditions is discussed, and some of the ways in which the conditions are really proving beneficial are pointed out. E.J.V.

BOOK

Sprechsaal 1932 Calendar for Ceramics, Glass, and Enamel. (In German.) Verlag Sprechsaal, Coburg, 1931. 344 pp. 30 illustrations. 2.50 Rm. Reviewed in *Glastech. Ber.*, **10** [1], 60 (1932).—The largest part of this book treats the fields of glass technique: glass raw materials, glass-forming systems, glass constants and properties, glass batches, raw materials of glass ceramics, and refractories. The three-compound system, natrium metasilicate–calcium metasilicate–silicic acid, and the properties of other important glasses are discussed. Glass etching and polishing, cements and glues for glass, data on enamels, and some X-ray methods are given. M.V.K.

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Vol. 11 **April, 1932** **No. 4**

EDITORIALS

PRESIDENTIAL ADDRESS FOR THE THIRTY-FOURTH ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY*

BY ECKARDT V. ESKESEN

Ladies and Gentlemen and Founders and Members of the AMERICAN CERAMIC SOCIETY:

A year has passed since our Meeting in Cleveland. It has been a year the like of which few of us have ever seen. Everywhere in the world it is the same: depression, unemployment, poverty, and inactivity. The year 1931 has come and gone, bringing no relief. We wonder whether the year 1932 will bring a change for the better. We feel as if we are marooned on a ship waiting for the mist to clear so that we can find a channel which will bring us into safe harbor.

We regret the absence of our honorable past-president, General Edward Orton, Jr., who a year ago presided and inspired us by his personality.

* Delivered at the General Session meeting held Monday night, February 8, 1932. Willard Hotel, Washington, D. C.

He is at his home, confined by illness. We all miss him—miss him because we are wont to have his counsel. We pray that he may soon recover his health.

General Orton has all these years been closely associated with the AMERICAN CERAMIC SOCIETY and with the ceramic industries of America. You cannot talk about ceramics and ceramic education in the United States without mentioning General Orton's name. He is one of the founders of the SOCIETY, one of its organizers. From its inception thirty-four years ago, when a small group of men met to organize the AMERICAN CERAMIC SOCIETY, until today, General Orton has been an active spirit in the SOCIETY, working, teaching, and taking the leadership, and he has seen it grow until it is one of the largest societies in the United States with membership the world over. Many of the founders, whose names we know and whose acquaintance we have cherished, have passed beyond.

But to those who are still with us let us give thanks and praise for the work which they did for this SOCIETY and for the ideas and inspiration which they have imparted to the younger generation—inspiration to reach for even greater ideals and advance to further achievement and success.

I shall not dwell on the history of the SOCIETY. General Orton ably sketched this history for you last year. I want to touch on the problems which today confront us, not alone in the AMERICAN CERAMIC SOCIETY but in the world at large.

Present Business Conditions: Cause and Cure

When we met a year ago we all asked the question, "How long will this last?"—meaning depression and unemployment, and we still ask the question, "How long will it last?"—and nobody can answer us.

All of our financiers, professors of economy, and statesmen have been dulling us with wise talk about how it all came about, how we have had situations like this before, and how it will all cure itself in proper time.

But some of us do not believe that things will cure themselves. The machinery (industry and commerce) has run dry and has stalled on us.

I do not believe in sitting down with our hands folded, saying, "Things will come out allright again." The present situation is a problem which the world has never before faced. It has come down upon us slowly, descending during the last decade, and could not, like old age, be prevented.

The framework on which society rests today seems to be "demand and supply." The supply of this world's necessities, requirements, and luxuries, has increased during the last decade due to the many inventions

in machinery and labor-saving devices, but at the same time the demand has been steadily decreasing.

We are able today, on account of improved machinery, to produce two to three times as much goods as we did twenty to thirty years ago with the same labor force. The farmer is tilling his soil with machinery; the boys have left the farms for a college education or to work in the factory (more pleasure and freedom), and now only one out of every three boys has his job and that at a reduction in wages.

The boy without a job has no buying power. He does not consume his share of the world's supply, and for this and other reasons we have over-production. Demand and supply do not meet.

The only way to make demand and supply meet is to provide work for the boys now walking the streets. We shall never see the day again in commerce or in industry when the world in time of peace will be able to provide a full day's work for everybody.

Where before it required one million boys and girls to produce all the shoes used in the United States, now one-half million or fewer are able to provide all the shoes we need. One-half million boys formerly busy making shoes are now walking the streets and are unable to buy their own shoes.

It was only a few years ago that the philosophers were telling us that the world was over-populated; today they are discussing over-production.

What is the solution to this problem of unemployment? I do not see that there is any other cure but that of providing employment for everybody even to the point of reducing the present day's working hours to a six- or four-hour day. This would provide jobs for those now unemployed, giving back to them their buying power. This would again start factories and mines, creating plenty for all.

If we want to make this country endure as the land of the free, we must provide a job for every man and woman who wants to work. We do not want circumstances to enthrall us and destroy us and our institutions. We do not want a situation here such as exists in some parts of Europe where tyrants and dictators or cliques of visionaries rule millions of people; a situation worse than under the rule of the kings and kaisers.

These questions are of vital interest and concern for all of us. Our own industry is perhaps as much, if not more, affected by what we call "bad times" as is any other industry in the United States.

How This Society Has Fared

I am pleased to report that the SOCIETY has not experienced any setbacks though its membership has not fared so well. Our income has not, even allowing for these bad times, decreased, but shows, without taking into account some contributions, an increase over the preceding year.

We have been able, praise to our worthy Secretary and his valuable staff, to decrease our expenses considerably for 1931 over those of the preceding year, so that the annual budget shows a balance or gain of a couple of thousand dollars. I may add that this result has been obtained without in any way entrenching on the activities of the SOCIETY or impairing its good-will or power of service. For this I feel grateful.

I took the office of President at a very trying time when our industry was passing through a period of depression. I wondered at the time how I could be of the most service to the SOCIETY, whether I could help it grow toward something greater and more perfect; for this SOCIETY is yet, even if it is thirty-four years old, in its infancy. Before us are new problems of how to make our products more useful, more beautiful, more perfect.

When I look around me in this hall and see men assembled here, who are vitally interested in ceramics, many of you ceramists and professors in ceramics, I ask myself how I, who am not a ceramist, who have had no schooling in ceramics, and who cannot read a molecular formula, can be of service to you.

My manhood years have been spent in producing out of the raw materials, things that will remain useful and beautiful long after I have gone away. It is a great comfort to be able to say that you have made things of usefulness and beauty that will endure.

If I were not a manufacturer, I might perhaps for the joy of it be a ceramist. Now I can only hope to inspire into those who work with me a desire to make things more beautiful and more worthwhile.

It must be great to be a ceramist or chemist and play with the elements, to delve into the undiscovered, to make new products, to solve production problems.

We are not bound by tradition nor is our field limited. There will always in this great, open, and rural country of ours be a demand for our product, whether it be things made of common clay or the most exquisite little porcelain statuaries produced in the factories of the Royal Copenhagen, Dresden, or Lenox.

We are, without doubt, entering upon an era when man must more than ever before be specializing in order to keep ahead of the times. If he has not himself the knowledge required he must employ those who are experienced in the line in which he is interested or into which he desires to enter. The ceramic schools furnish us with experts who make certain branches their specialty. We have several schools teaching ceramics, each in a different way, and by different methods and means. Some specialize more in one branch than in another, and it is therefore up to the young student to select his study and to decide in what branch he wants to become an expert.

But a school of book learning will never make a student a leader unless he knows how to acquire practical knowledge and how to apply this knowledge.

This SOCIETY is essentially a school in its aim and purpose. It is an extension course after the preliminary schooling has been finished. Information distributed by this SOCIETY is as essential and as necessary to be followed as any schooling. By arranging this Annual Meeting and many other meetings, this SOCIETY, with its branches and its direct connection with the many ceramic schools, acts as a forum where men come together and discuss their problems. It is carrying on an education through the publication of its *Journal*, and otherwise acts as a medium for disseminating and exchanging thoughts. It is still teaching and instructing and is the main source to which ceramists come for knowledge and information.

A Challenge The dream of the modern architect is to build houses entirely out of metal, glass, and cement, with all furniture and utensils of metal. In this construction, brick, tile, or terra cotta has no place. It may only be a dream, yet the tendency is already there in our modern skyscraper—monotone, with lines up and down or across—no ornamentation, curves, projections, relief, or color.

I do not believe that man will ever be contented to live and work in houses of that sort. We are not entering another iron age. We refuse to be standardized. The yearning today is toward beauty and individuality in everything, in our homes and surroundings, and nobody shall dictate to us that we cannot have those beautiful things which are made of clay and glass. It has been said, and we still keep saying, that a vase made of clay is "a thing of beauty and a joy forever." Why can we not as proudly say it about all of our products?

There have always through all ages been men who delighted to work with their hands and brain to produce out of the common clay the things that are useful and beautiful. We admire the della Robbias and the masters of the Renaissance, but we of today with our modern equipment and schooling have far outdistanced the della Robbias, of whom it was said that they could never be imitated.

It is our dream to see a new renaissance in this our America. We want our cities to use our material inside and outside because it has life and color; we do not like to see our cities draped all in gray. We want our material, from the coarsest to the most tender, used in our houses outside and inside for beauty and comfort.

Admiring the great work done by this SOCIETY in the past and knowing it to be a rock of Gibralter upon which we can rely, I am looking expectantly toward the future and hope to have many years more to see it grow increasingly useful to the ceramic industries.

FARADAY'S RESEARCHES ON OPTICAL GLASS[1]

By C. D. Spencer and Shannon Jones

The past year has marked the centenary of Michael Faraday's great discovery of electromagnetic induction. Scientific societies all over the world have concurred in offering some form of tribute in honor of one of the most versatile of scientific investigators. As an indication of the widespread interest, not only of scientists but of the public in general, in the accomplishments of Faraday it is interesting to note that *The Times* of London published on September 21, 1931, a special supplement to the regular edition dedicated to Faraday. This supplement contained thirteen full pages devoted to articles on Faraday's life and work and to a description of modern industries founded on his discoveries. As far as we know this is the first instance in which a great daily newspaper has so honored the memory of a scientist. It seems fitting that the Glass Division of the American Ceramic Society should pay its respects to Faraday as one of the early investigators in the field of optical glass.

A number of years ago Dr. E. W. Washburn reviewed for us Faraday's paper "On the Manufacture of Glass for Optical Purposes." This was the first of Faraday's Bakerian Lectures and was read before the Royal Society on November 19, December 3, and December 10, 1829. The fact that it was necessary to present the paper in three parts is some indication of its length and the minute detail with which Faraday described his experiments. It is true that Faraday's investigations on glassmaking resulted in no great technical achievements, still his report makes interesting reading even today. His paper was published in full in the *Transactions of the Royal Society*,[2] and in the volume of Experimental Researches in Chemistry and Physics.

An interesting digest of Faraday's researches on optical glass with many extracts from Faraday's original manuscript volumes is given in a recent paper by Arthur Marshall.[3] These manuscript volumes have recently been discovered in the library of the Royal Society. They give us intimate glimpses of Faraday at work.

Faraday's experiments in glassmaking were carried out with a batch composed of lead oxide, boric acid, and silica. His method was to fuse the batch in a clay crucible and then to remelt the broken mass in platinum trays. We can sympathize with Faraday when he remarks that his earthenware crucibles did not give satisfactory service. All through his

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[1] Received at the Annual Meeting, American Ceramic Society, Washington, D. C., Februtry, 1932.

[2] *Phil. Trans.*, **128**, 1 (1830).

[3] Arthur Marshall, "Faraday's Researches in Optical Glass," *Jour. Soc. Glass Tech.*, **15**, 212–18 (1931).

experiments he experienced considerable difficulty in obtaining suitable refractories for his crucibles.

Faraday introduced the use of platinum-black to assist in clearing the molten glass of small bubbles. He devised a method of forming a tray from one piece of heavy platinum foil about 0.1 mm. in thickness and he discovered that the platinum foil could be stripped from the cold glass and used over again. Melt 174, composed of equal equivalents of lead oxide, boric acid, and silica, is of particular interest because Faraday discovered the magnetic rotation of the plane of polarization of light with a specimen of this glass. Faraday's investigations in glassmaking were initiated in 1825 when he was appointed a member of the sub-committee of the Royal Society to consider the improvement of optical glass for telescope objectives. His interest in the problem was continued until the end of the year 1830 when the pressure of the great amount of work he was doing forced him to discontinue his activities along these lines. It was at this time that he decided to devote the remainder of his life to investigations in pure science. And we, as glass technologists, are undoubtedly the poorer for his decision.

General Electric Company
Glass Technology Laboratory
Nela Park
Cleveland, Ohio

ACTIVITIES OF THE SOCIETY

THE THIRTY-FOURTH ANNUAL MEETING

Wow! What a successful Meeting!

There were 438 members, 39 guests, and 44 ladies registered. There were 304 railroad tickets viséed. Four hundred and thirty-seven members and guests were at President Hoover's lawn reception. One hundred and sixty-two ladies attended Mrs. Hoover's reception. Over one hundred and fifty persons went to Baltimore on Friday. The Materials and Equipment Division dance and frolic in the Hall of Nations of the Hotel Washington was attended by more than five hundred.

These attendance data do not tell the whole story. There were several persons, as always, who did not register; more this year than usual because of the $2.00 registration fee. Many of the ladies were not registered as evidenced by the number who attended the teas and Mrs. Hoover's reception.

The technical meetings were well attended—some of them with capacity audiences. The programs held the interest of the members. The Willard Hotel management remarked on the attendance of the delegates at the Division Meetings; very few were found in the lobby during the Meeting hours.

The delegates were in Washington in large numbers on Sunday. By Monday morning the capacity of Willard Hotel was reached. Delegates came early and stayed through the week.

It was not surprising that many motored to Washington from points northeast, from New York; west, from Ohio; south, from Georgia. Ideal weather prevailed, making motoring an added delight.

The local committeemen were always alert to serve in their respectively assigned capacities. L. J. Trostel, general chairman, and his fellow committeemen, including ladies, deserve unstinted praise.

The Willard Hotel, unused to the emergencies of our SOCIETY Meetings, promptly met the many situations with ample provisions. They responded to all requests, all overflows, and all attendance shortages in a satisfactory manner. Though the main lobby was being remodeled and dust and disorder was everywhere, and a rat-a-tat tat of hammers and drills of the boiler shop variety made ears ring on Sunday forenoon, a swift cleanup and a withdrawal of the reconstruction crew were made so that from Sunday noon on the delegates were undisturbed. This was appreciated.

General Meeting Monday Night

Count Eckardt V. Eskesen, our president, pleased the members by the promptness and ease with which he conducted the two general meetings. His address is one of the editorials of this *Bulletin* issue. The addresses of Dr. Frederick Willson, Mr. Richard F. Bach, and of Dr. John C. Hostetter were listened to attentively, the large audience staying through until the last speaker concluded.

Materials and Equipment Frolic

In the Hall of Nations, Hotel Washington, where it is said that 250 couples can dance without crowding, there was a capacity attendance. Several persons stated that this dance was the most enjoyable social occasion ever held at one of our Annual Meetings. Henry Kleinfeldt, Vic Kelsey, and Gage Lord deserve much credit for this enjoyable evening.

Purdy's fifty daughters, all winsome and gay, were there, adding beauty and pleasure.

Bill Harrison was their sponsor and right proud of them as he might well be—and as was Purdy.

Seeing Washington

The local committee, efficient, always on the job (An. Finn, chairman), moved large parties of delegates on the several trips with an unusual precision and snap. Every one was able to see all that he wished in the limited time available.

The ladies, under Mrs. Herbert Insley and Mrs. R. T. Stull, were transported by groups to places of their several selections. On returning to the hotel late in the afternoons tea awaited the ladies—and the men, too. These teas were delightful.

The President's Reception and Dance

This formal affair was canceled in honor of Past-President General Edward Orton, Jr., word of whose death was received in the late afternoon. In its place, a general meeting was announced for the purpose of installing the officers elect and of holding a memorial service in commemoration of General Orton. The story of the memorial service was published in the March issue of the *Bulletin*. The account of the installation exercises appears in this issue of the *Bulletin*.

The Division Meetings

As this Annual Meeting was held far distant from the geographic center of the ceramic industries, and in a year of acute business depression, so many delegates from afar were not expected. The registration count does not reflect the number attending. Most of the Divisions had "bumper" crowds.

Here is where Dr. Herbert Insley served most efficiently. He had charge of the meeting room supplies. His crew was on the job early; every meeting had a lantern, screen, and blackboard promptly. Herb Insley met an unexpected demand for a reflectoscope with no hestitation. "Ask and ye shall receive," was the motto of Herb and his gang.

The National Brick Manufacturers Research Foundation

A creation of this Society for the specific purpose of promoting researches of value to structural clay product producers—this Foundation is substantial. The first meeting under the new organization was highly successful. General Edward Orton, Jr., John Martin, Douglas Stevens, Henry Kleymeyer, Howells Fréchette, Ed Krauss, James Randall, Amos Potts, with the aid of the other Structural Clay Products Division officers, effected the organization of this Foundation.

The work on reinforced brick masonry which the Foundation has accomplished under the leadership of Ed Krauss has aroused a great deal of constructive interest.

Maya Architecture

One of the delightful and profitable luncheon meetings was held Tuesday noon. George Oakley Totten, Jr., president of the Washington, D. C., Chapter, American Institute of Architects, gave an illustrated lecture on Maya Architecture. Mr. Totten's address was far from being a recital of archaeological facts. He discussed architectural trends in construction and decoration. He brought out vividly how highly the building arts were advanced in those long ago centuries in America—centuries before the rediscovery of America by Columbus.

One cannot view the wonderful Maya constructions and architectural decorations without wondering how far, after all, we have progressed.

Mr. Totten's address was a treat to those who attended this noonday luncheon.

To Rom Geller, George W. Morey, and the other local committeemen who have

not been mentioned before, the delegates expressed their appreciation for arranging so many profitable and enjoyable affairs.

To Past-President Eskesen and his Board of Trustees, to the Division and Foundation officers, the success of the Thirty-Fourth Annual Meeting is credited. A record of accomplishments was made even though the attendance fell far short of the 1700 mark made last year in Cleveland.

Eight simultaneous meetings covering the whole ceramic field in clay, glass, and vitreous enamels—this is the scope of the AMERICAN CERAMIC SOCIETY's Annual Meetings.

BALTIMORE DAY

February 12, 1932

The Baltimore Committee apparently slipped on one detail in their plans for entertaining the SOCIETY. They had not consulted the weather man who served up a rather dour variety of weather to greet the crowd who had journeyed over from Washington.

Buses furnished through the courtesy of the Baltimore ceramic industries met the party at the Camden Station of the Baltimore and Ohio R. R. at 10:00 A.M., and carried them directly to the plant of the Locke Insulator Company on the bay. Here the crowd was handled efficiently through the plant in small groups for an inspection of the various processes and tests necessary for the manufacture of electrical porcelain. Then the whole party met in the high voltage electrical testing laboratory for the big electrical show. A demonstration was made of an oil fire started by artificial lightning and how oil storage reservoirs may be protected from this hazard. A string of 24 suspension insulators about ten feet long was flashed over under 3,000,000 volts to demonstrate the ability of the porcelain to withstand very high voltages without damage. A weird floating flame of 1,000,000 volts was the final demonstration.

The exhibition was most spectacular throughout with the tremendous arcs and great corona discharges showing up with great brilliance in the darkened room, all accompanied by ear-splitting synthetic thunderclaps. One could not help but be impressed with this evidence of the ability of the Locke engineers to harness and control such great forces and put them to work for the routine testing of their electrical porcelain.

While en route from the Locke plant to the Emerson Hotel downtown for lunch the buses stopped for a few minutes to view the extensive development of piers of the City of Baltimore and the Western Maryland Railroad. Opportunity was given to see the facilities for handling ocean-going freight and some of the advantages of the Port of Baltimore as an export point were pointed out.

At the Emerson Hotel a buffet luncheon was served at 12:30 to one hundred and fifty-one people. It had been planned to permit President Eskesen to sing his "swan song" on this occasion, but all speeches were dispensed with in view of the passing of General Orton.

By 1:30 the various inspection trips to various local ceramic plants were well under way.

It was largely a field day for the enamelers judging from the crowd of seventy-five persons who elected this trip. This itinerary included first the Baltimore Enamel and Novelty Company, probably the largest and oldest manufacturers of enameled signs in this country; the Porcelain Enamel Manufacturing Company, making both wet- and dry-process enamels and whose physical research laboratory attracted a great deal of attention in view of its high degree of development, especially in this field; and finally the plant of the Standard Sanitary Company, which afforded an opportunity to see the

use of dry-process enameling on sanitary ware in one of the most modern plants of its kind.

About twenty-five people took the glass trip which included the Carr-Lowery Company specializing in perfumers and druggists' bottles manufactured by the hand, semi-automatic, and full-automatic processes, and the Maryland Glass Company. This is the home of the familiar blue Bromo-Seltzer bottles, though blue and brown glass for other lines are made, all by the full-automatic process.

One bus load of fifteen persons took the twenty-mile trip down the bay to the Bethlehem Steel Company's enormous plant at Sparrows Point. An opportunity was afforded to see the lining of one of the world's largest blast furnaces as well as several open-hearth furnaces in various stages of reconstruction. The charging and tapping of the latter furnaces besides indicating a type of service that refractories must withstand were also interesting because of their spectacular nature.

The Edwin Bennett Potteries established in 1846 and one of the oldest in the country, entertained a small group of people interested in white ware pottery. It is probably of considerable historical interest to the ceramic profession to know that it was a member of this same Bennett family who was responsible for the establishment of the great pottery center now localized on the Ohio River about East Liverpool, Ohio.

Provision was made for those not interested in the plant trips to get a glimpse of the historical background of Baltimore by means of a sight-seeing trip. W. A. Weldon of the Locke Company, acted as "spieler," a most happy choice in view of his deep interest and appreciation of the various civic features of this city.

The most prominent of the various places visited in the heart of downtown Baltimore included Edgar Allan Poe's tomb in old Westminster Churchyard; the first Washington Monument in the United States, erected in 1815; the Shot Tower, a unique structure erected in 1828 and the only one in this country; Fort McHenry, scene of the memorable repulse of the British fleet in 1814 which inspired Francis Scott Key's writing of "The Star-Spangled Banner"; the Flag House where this same banner was made; and finally a tour of the water-front affording an opportunity to see ocean liners and freighters and the other water life which is typical of Baltimore.

The Baltimore Committee caught up with the weather man for he turned on a bright sunshiny afternoon for the various trips and thus helped add to their general enjoyment.

EDITOR'S NOTE: Because of unexpected change in plans due to the death of General Orton, no one from the Secretary's office made the trip to Baltimore. The preceding notice was written by the chairman of the Baltimore Committee, our genial and competent Louis Trostel. Of course "Louie" was loath to give himself due amount of praise; instead, he was inclined to take part of the blame for the inclement weather. The Secretary therefore feels that a word must be added emphasizing the completeness and excellence of the arrangements for those members of the SOCIETY who made the trip. And the deepest appreciation must be expressed to "Louie" for his hard work, not only on Baltimore Day, but during the months preceding the visit, spent in making the arrangements for the trip.

W. A. Weldon has demonstrated his fascinating ability of "debunking" history and putting historical myths in their true place, and we are sure that anyone who joined the group in which Mr. Weldon acted as guide felt repaid for the thorough "review course" in early Americana. It was Weldon who conceived and developed the enthusiasm for the "day in Baltimore."

For the other members of the committee, "Louie" admits that he would have had a hard time as a "chairman host" without the willing and ready assistance of Roy A. Blunt, E. H. Filbert, C. B. McComas, L. C. Roche, B. T. Sweely, and Richard Turk.

INDUCTION OF OFFICERS FOR 1932–33

A special meeting of the AMERICAN CERAMIC SOCIETY was called on Wednesday evening, February 10, 1932, Willard Hotel, Washington, D. C.

The reception and ball, scheduled by President Eskesen to follow the induction services, were canceled because of the passing of the founder of the AMERICAN CERAMIC SOCIETY. The following program of induction of officers was carried out, followed by the memorial services for General Edward Orton, Jr.

PRESIDENT ESKESEN: Last night in my presidential address I regretted that we could not have General Orton with us. Today, we received the sad news of the passing of our beloved past-president. We are very sad and out of spirits.

A year ago I was elected to the office of president of this SOCIETY. I was elected, I understand, because I am a practical man. I hope that I have been a practical man for the SOCIETY. I do not know whether I have brought in any practical results. I am more of a dreamer than a practical man, if I may say so. And it may be, that because I am a dreamer the practical work which I have had to do in this world has a push to it, and that this has helped me push along the work of this SOCIETY.

I think we all should have a little bit of the dreamer in everything that we do. I have been a dreamer for years. As a young man I wrote poetry and read literature. I published poetry and received praise for it, but I found that I had to quit the poetry and dream in other ways—for instance, dream of building and producing things.

This year has passed quickly, like a dream. It has been a happy year for me to have been able to serve the SOCIETY as president, and to have added many valuable and staunch friends to the many friends I already had.

This is a sort of farewell speech because I am now releasing this office. I should like to say a few words to Mr. Purdy, our worthy secretary, and to thank him and his valuable staff for the coöperation that they have given me during my period as president. Everything has been harmonious. Mr. Purdy and I have been good comrades for many years and this past year has been the finest time I have had. I thank Mr. Purdy and his staff for the forebearing and valuable assistance that they have given me.

When I took this office I did not know where to begin. I had been a member of this SOCIETY only, had never held an office, had been to only a few of the meetings. I know much more about the SOCIETY and this office, and now that it is time to give it up I am saddened. I have learned many things about the organization and working of the SOCIETY and a little bit of how to run it, and now I must leave it.

I want to wish success to those officers who now take the office and I wish to thank you all for this past year.

Fellow Diplomas I have some diplomas which have been issued to Fellows. (Dr. Bole received the diplomas for the following persons:)

Thomas Newkirk McVay
John D. Martin
Howells Fréchette
Arthur Van Henry
Robert Linton
C. Forrest Tefft
Andrew I. Andrews

Induction of New Officers MR. ESKESEN: We are now ready to induct the new officers of the SOCIETY.

MR. PURDY: Mr. President, the Teller's Committee has reported the election of the following officers of the SOCIETY for the year 1932–33:

President, Emerson P. Poste; *Vice-President*, William Keith McAfee; *Treasurer*, H. B. Henderson; *Enamel Division Trustee*, Walter Lindemann[1]; *Glass Division Trustee*, Francis C. Flint; *White Wares Division Trustee*, Daniel Parry Forst.

[1] Mr. Lindemann was elected to fill out the uncompleted term of Emerson P. Poste.

PRESIDENT ESKESEN: I shall ask you to receive the oath of office. I cannot do anything better than to use the exact words spoken to me last year in Cleveland by our beloved past-president, General Orton.

Gentlemen, you are about to be inducted as officers of the AMERICAN CERAMIC SOCIETY. Men become truly great only through the use of their faculties in behalf of their fellowmen. Great abilities devoted to selfish or personal ends may gain wealth, power, rank, adulation, but in the end these things turn to dust, leaving behind only a fleeting memory.

Organizations are like men. They are built of human units, and like these units they are bound by the same immutable laws. They become great by service, and by service only. Insofar as they reflect the high and noble ideals of their members, they grow in influence and prestige.

The AMERICAN CERAMIC SOCIETY was founded and has been carried on for these thirty-three (thirty-four) years in the spirit of high purpose, to add to human knowledge, to promote acquaintance, to break down the barriers of a narrow, self-defeating secrecy, and to substitute in its place friendly coöperation, all for the greater good and glory of mankind.

You who are about to assume the direction of the affairs of this SOCIETY are greatly favored men, not because of the honor that has been conferred upon you, but because of the opportunity that is yours. You have a great responsibility to carry forward nobly the noble traditions of this SOCIETY. You are blessed above others in that your fellow members have selected you as the fitting representatives of this body to carry forward these traditions.

Will you kindly hold up your right hand?

With knowledge of the high and altruistic purposes of the AMERICAN CERAMIC SOCIETY, and of the great scientific advance which it has inspired and stimulated during its thirty-four years of existence, and of the marvelous and far-reaching changes in industrial coöperation and friendly interchange of professional knowledge which it has brought about through the friendships here engendered, and with a deep sense of the obligation to perpetuate its achievements, and still further enlarge the usefulness of the SOCIETY to the ceramic industries of the United States and of the world,

Do you accept the offices to which you have been elected and here, in the presence of this gathering, consecrate yourselves to the duties of your several offices and promise to do what lies within you to be worthy of the trust now imposed in you?

By virtue of the authority temporarily vested in me, as President of this SOCIETY, I pronounce these men duly qualified and elected officers of this SOCIETY and I extend the right hand of fellowship.

President Poste took the chair.

PRESIDENT POSTE: In view of the telegrams on this table, it would seem unfitting for me to take time with unnecessary words. The oath of office, which we have just taken part in, has involved the words of our parting leader and certainly, nothing that I could say would, in any way, add to or amplify these sentiments.

I do appreciate the honor. I appreciate the responsibility that goes with it. I am sure that with the inspiration of those who have gone before I shall do my best to fulfil the functions of this office.

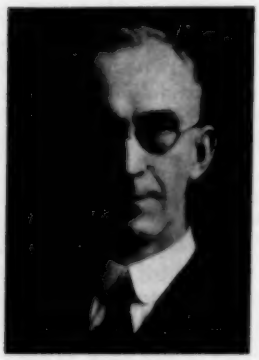
VICE-PRESIDENT MCAFEE: Mr. President, Mr. Past-President, Ladies, and Gentlemen: The vice-president, as I see the office, is not one who comes before the public eye.

I thank you for the honor that you have conferred upon me. I will try to prove myself worthy of the office by supporting the régime of Mr. Poste.

The remainder of the session consisted of the Memorial Services for General Orton, transcription of which appeared in the March *Bulletin*, pp. 55–60.

OUR NEW OFFICERS ELECT

In addition to our earnest and faithful treasurer, H. B. Henderson, to whom the members year after year have given a vote of trust and recognition, the SOCIETY is honored and is to be congratulated on the following newly elected officers:



H. B. HENDERSON

EMERSON P. POSTE

Emerson P. Poste was born in Naples, New York, in 1888. He received his degree of B.S. from the Department of Chemical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., in 1910. From 1910 to 1912, he was assistant instructor and research assistant to the head of the Department of Chemical Engineering, Carnegie Institute. From 1912 to 1916, Mr. Poste was chemist with the Enameled Pipe & Engineering Company of Elyria, Ohio, and from 1916 to 1924 he was director of laboratories of the Elyria Enameled Products Company, Elyria, Ohio.

In 1924 the Elyria Enamel Products Company merged with the Pfaudler Company, Rochester, N. Y., and for the following two years, Mr. Poste was director of the Elyria Laboratories of the Pfaudler Company.

In October, 1925, he became associated with the Chattanooga Stamping & Enameling Company, Chattanooga, Tenn., as chemical engineer in charge of enamel processing. In 1929, he served as factory manager and during the years 1930–1931 he was assistant secretary and chemical engineer for the same company. During 1930 and 1931 he also engaged in an outside consulting practice in chemical engineering.

Although Mr. Poste is still connected with the same company, chiefly on a consulting basis, he is devoting most of his time to his consulting work. He has established a chemical laboratory in connection with the laboratory of the Chattanooga Stamping & Enameling Company.

E. P. POSTE

Mr. Poste has been an active member of the AMERICAN CERAMIC SOCIETY since 1912. He was chairman of the Northern Ohio Section of the SOCIETY from 1918 to 1920 and chairman of the Enamel Division during 1920–1921. During 1922–1923 he served on the Standards Committee as a representative of the Enamel Division and was a member of the standing Committee on Membership.

He is also a member of the following technical organizations: American Chemical Society, American Institute of Chemical Engineers, American Association for the Advancement of Science, American Welding Society, Cleveland Engineering Society, the English Society of Glass Technology, and The Chattanooga Engineers Club, acting as president of the latter organization in 1929.

Mr. Poste is a member of the Pilgrim Congregational Church and chairman of the Board of Trustees for 1931–1932. He is also secretary of the Chattanooga Rotary Club, on the Central Committee and chairman of the Educational Committee of the Chattanooga Y. M. C. A., and a member of the Meadowlake Golf and Country Club.

W. KEITH McAFEE

Vice-President, American Ceramic Society

Our newly inducted vice-president needs no introduction to the members of the AMERICAN CERAMIC SOCIETY. He has been actively interested and a worker in the SOCIETY since he became a member in 1923. He has served as Chairman of the Education Committee and Chairman of the Pittsburgh Local Section of the SOCIETY, and is at present Chairman of the Committee on Management and a member of the Committee on Education. He was awarded his certificate of Fellowship in the SOCIETY in Cleveland, 1931. He has also been affiliated with the Ohio Ceramic Industries Association since the beginning of its organization and has served as its Secretary-Treasurer and President, holding the latter office in 1929.

W. K. McAFEE

Since 1928 he has been President and General Manager of the Universal Sanitary Mfg. Company at New Castle, Pa.

A biographical sketch and photograph of Mr. McAfee were published in the January, 1926, issue of the *Bulletin of the American Ceramic Society*.

W. C. LINDEMANN

Trustee, Enamel Division

Walter C. Lindemann, the newly elected Trustee of the Enamel Division, will take the place on the Board of Trustees made vacant by the election of E. P. Poste as President of the SOCIETY.

W. C. LINDEMANN

Mr. Lindemann has been a member of the AMERICAN CERAMIC SOCIETY since 1919 and was inducted into the Fellowship in Cleveland, Ohio, February, 1931.

He was graduated from the School of Engineering of the University of Wisconsin in 1908. He then attended the Charlottenburg University, Germany, for one year of postgraduate engineering work. Since 1909 he has been employed at the A. J. Lindemann & Hoverson Company, Milwaukee, Wis., as foreman, chief engineer, superintendent, and at present factory manager.

FRANCIS C. FLINT

Trustee, Glass Division

As the new Trustee representative of the Glass Division, Francis C. Flint represents one of the most active workers of the SOCIETY, oftentimes accomplishing definite results for the good of the SOCIETY without benefit of office. During 1930–1931, he was Chairman of the Committee on Membership and carried on a vigorous campaign to secure members on the basis of the high privilege which affiliation with the SOCIETY

could offer them. He was also honored by induction into the group of Fellows of the AMERICAN CERAMIC SOCIETY in Cleveland, Ohio, in 1931.

Mr. Flint received his B.S. degree in chemistry from Pomona College in California in 1915 and took graduate work at the University of California. He taught chemistry at Pomona College until 1918, and the next two years was with DuPont's in New Jersey. Since 1920 he has been chief chemist for the Hazel-Atlas Glass Company, Washington, Pa.

F. C. FLINT

In 1926 Mr. Flint was elected Chairman of the Glass Division and immediately set about to bring the members of this Division closer together, as well as to draw the Division more closely to the parent SOCIETY. Invitations were issued to the Division members for a summer meeting at Cove Point, Md. This meeting was so successful in cementing old friendships and meeting new members informally that the Summer Meeting of the Glass Division has since become an institution of the Division eagerly awaited by its members and their friends. In the summer of 1931 the members admitted ladies for the first time at their gathering, and the place of meeting was changed to Old Point Comfort, Va.

The members of the Glass Division are to be congratulated to have secured Mr. Flint's services as their Trustee for the next three years.

DANIEL PARRY FORST

Trustee, White Wares Division

Mr. Forst has been a member of the AMERICAN CERAMIC SOCIETY since 1913 and an active worker in the White Wares Division. He has also held office as president of the New Jersey Clay Workers Association.

His preliminary education was obtained at Mercersburg Academy, and after his graduation from Princeton in 1912 where he secured an A.B. degree, he took a three year post-graduate course in ceramics at Ohio State University. From 1917 to 1919 he was lieutenant in the Field Artillery of the U. S. Army.

In 1920 Mr. Forst became factory manager of the Robertson Art Tile Company and since 1929 has served as president of the same company.

D. P. FORST

REPORT OF MEETING OF THE BOARD OF TRUSTEES

Gridiron Room, Willard Hotel, Washington, D. C., February 7, 1932

Those present were Eskesen, Silverman, Bole, Henderson, Flint, Poste, Kleymeyer, Schurecht, McKinley, Kelsey, Schramm, and McAfee.

Those absent were Orton, Sebring, Spencer, and Lindemann.

(1) The Teller Committee, consisting of Robert Sherwood and George Brain, reported count of the ballots as follows:

President: Emerson P. Poste
Vice-President: W. Keith McAfee
Treasurer: H. B. Henderson
Glass Division Trustee: Francis C. Flint
White Wares Division Trustee: D. Parry Forst
Walter Lindemann was elected to fill out Mr. Poste's unexpired term in the Enamel Division.

(2) Letters from Mrs. Edward Orton, Jr., were read. The Secretary was instructed to telegraph greetings to her, also to express profound regret that General Edward Orton could not be in attendance at this meeting. He was also instructed to prepare suitable resolutions to present to the SOCIETY. G. A. Bole and E. P. Poste formed this committee.

(3) Reports of Executive Committee meetings of April 17, July 17, and November 13, 1931, were read and approved.

(4) H. G. Schurecht was given proxy to act for D. F. Albery.

(5) The officers elect were granted voice and vote.

(6) The Minutes of the Cleveland Meeting of the Board of Trustees were read and approved.

(7) The Honorary Membership rules were discussed. It was moved by Poste, seconded by Bole, that a committee consisting of Silverman, Henderson, and Schramm be appointed to formulate recommendations on Honorary Membership rules. The elections of Dr. Arthur L. Day, Dr. J. W. Mellor, and Dr. Otto Schott were confirmed unanimously.

(8) Mr. Bole requested information as to why American Refractories Institute canceled its contract with this SOCIETY. Mr. McKinley explained that there was no friction. The American Refractories Institute has suffered large losses in firm members due to combinations and discontinuances. The present members believed it advantageous to foster research, and to hold technical sessions wholly under the auspices of the American Refractories Institute.

(9) The report of the Treasurer, on motion of McKinley and Silverman, was adopted.

(10) It was moved by Kleymeyer, seconded by McKinley, that the SOCIETY's investment be placed in a bank trust subject to joint order of the President and Treasurer. Motion carried. The City National Bank and Trust Company of Columbus was designated.

(11) It was moved by McKinley and seconded by Kelsey that the Secretary be required to furnish the Treasurer with signed receipts covering all expenditures from the revolving fund. Motion carried.

(12) It was moved by Kleymeyer, seconded by Silverman, that the incoming President take out a blanket bond in an amount not exceeding $3000 covering the Secretary and Treasurer as agents for handling the SOCIETY's funds. Motion carried.

(13) It was moved by Silverman, seconded by Henderson, that the *Journal* be sent to those who request extension of time for paying dues if they are in good standing up to January 1, 1932.

(14) Resignations were reviewed and a unanimous agreement reached that each Trustee should confer with the officers of his respective Division regarding ways and means of securing reconsiderations by those who had resigned, and to secure larger Corporation member support.

(15) It was moved by Silverman, seconded by McKinley, that a committee be appointed to consider publication policies looking to increasing advertising income. Kelsey, McKinley, Schramm, and Poste were appointed on this committee.

Report of the Board of Trustees Meeting, February 8

(16) Minutes of the February 7 meeting were read and approved.

(17) It was unanimously agreed without motion that when the Board adjourned, it did so to meet Thursday noon at 12:30.

(18) W. Keith McAfee was appointed as representative of the SOCIETY on the Federal Specifications Board Committee on Plumbing.

(19) The dues of foreign members, on account of the large difference in exchange rates, were discussed and the action of the Executive Committee at its November meeting was approved.

(20) The Committee on Honorary Membership Rules (Silverman, Henderson, and Schramm) reported, and it was moved by Silverman, seconded by McAfee, that its report be referred to the Committee on Rules.

Honorary Members shall be nominated by at least ten Active Members and unanimously approved by the Board of Trustees. Such nominations shall be placed before the Fellows at their annual meeting and must receive the affirmative vote of at least 90% of those present and voting.

(21) It was moved by Schurecht, seconded by McAfee, that the 1933 Annual Meeting be held in Pittsburgh, provided the General Secretary can make satisfactory arrangements.

(22) President Eskesen suggested, and the other members approved, that the Secretary write a letter of thanks to the cities from which invitations have been received.

(23) It was moved by Silverman, seconded by Poste, that the Committee on Rules be recommended to consider changing the title of the office of vice-president to that of president-elect.

(24) Report of the Budget Committee was received, and on motion of J. N. McKinley, seconded by G. A. Bole, it was accepted. The report follows:

Report of Budget Committee, February 8, 1932

The total expenses of the AMERICAN CERAMIC SOCIETY for the year 1931 amounted to $43,633.56, as compared with a total for the year of 1930 of $48,414.62. The profit and loss account for the year 1931 shows a gain of $2078.03, which, substantially, is the amount of contributions received during 1931.

The Administrative Offices of the SOCIETY are to be commended for their adjustments of income and expenses to the budget laid down for 1931. When the 1931 budget was prepared, it was deemed inadvisable to attempt specific allocation of expense items. It is your Committee's thought and recommendation that our 1932 budget be written with the understanding that the items of distribution should be specific and that no increases, above the specified items, should be permitted, except under the direction of the Executive Committee.

As a further matter of general policy, your Budget Committee recommends that the 1932 budget be adjusted periodically during the year, if necessary, to meet income conditions. The specific budget structure is as follows:

Cost of Publication	$20,000	Traveling Expense	500
Abstracts	1,800	Committee Expense	
Reprints		Miscellaneous Expense	
Editor's Office Expense	1,250	Century of Progress	
Salaries	13,000	Depreciation	250
Secretary's Office Expense	1,700	Bad Accounts	200
Postage	1,250		
Office Rent	1,080	Total	$41,030

In view of the unusual conditions in the country at large, your Committee believes that the Board of Trustees in setting the budget for 1932 should make certain requirements mandatory in connection with the administration of the budget. Specifically, your Committee recommends the following items:

(*a*) No new equipment can be purchased, or capital expense incurred except by direction of Executive Committee.
(*b*) Steps should be taken at once to reduce rent, in line with current office rental reduction in all Ohio cities.
(*c*) The Century of Progress activity should be entirely suspended and not in any way revived, except by direction of the Executive Committee.
(*d*) Cut out all free reprints.
(*e*) Eliminate patent abstracts as at present given and list patents by title only.
(*f*) Eliminate all stenographic reporting at meetings, except by special arrangement covering specific cases; these arrangements to have the approval of the Board before they can be made.
(*g*) Reduce cost of illustrations in the *Journal* wherever possible by having the authors provide the necessary drawings made up using specifications laid down by the Secretary's Office.

It is not intended that this procedure shall extend to the point of depreciating the quality or appearance of the drawings, but it is believed that considerable progress can be made in reducing this cost.

Respectfully submitted,

H. C. Klevmeyer
H. B. Henderson
I. M. McKinley
E. P. Poste

(25) Mr. Poste moved that a vote of thanks be given to President E. V. Eskesen for the wonderful services which he had rendered during the year, and all members of the Board present immediately seconded the motion.

(26) Vice-Chairman of the Fellows, George A. Bole, presented the personal and professional records, signatures of sponsors and referees and record of action by the jurors, placing in nomination for Fellow membership C. Forrest Tefft, Howells Fréchette, Robert Linton, and John D. Martin. It was moved and seconded separately for each that these nominations to Fellowship be affirmed. The motion was carried.

Adjourned Meeting, Thursday Noon, 12:30

D. Parry Forst, Trustee of the White Wares Division, attended this meeting, having just arrived in Washington from a meeting of the tile manufacturers in Rochester, N. Y.

(27) The Secretary was instructed to have printed or engrossed suitable certificates of Honorary membership for the following: Dr. Arthur L. Day, Dr. J. W. Mellor, Dr. Otto Schott, Mrs. Maria Longworth Storer, and Dr. Edward W. Washburn.

(28) Charter certificates for Local Sections and university Student Branches were authorized without vote.

(29) The portion of the Budget Committee's report referring to abstracts was again discussed in connection with a verbal report brought by President Poste from the meeting of the Committee on Publications to the effect that abstracts of foreign patents should contain a brief abstract in addition to the title and patent numbers.

(30) The recommended changes in the Constitution which were approved by the Committee on Rules for submission to the Membership for vote in accordance with Article XIII, were published in the March *Bulletin*, p. 74.

(31) The question of filling the vacancy on the Board caused by the death of General Edward Orton, Jr., was briefly discussed. President Poste was instructed to secure

vote of the members of the Board. (Dr. Alexander Silverman, immediate past Vice-President, was elected by letter ballot.)

(32) It was moved by McAfee, seconded by Forst, that the President be empowered to appoint chairmen of the several standing committees, as provided for in the Constitution. This was carried.

(33) Mr. Kelsey brought up the question of publicity of ceramic products, making special reference to the English-made souvenir plates ordered by the D. A. R., and other patriotic organizations. Without formal vote it was the consensus of opinion that the SOCIETY could support publicity in general, but could not engage in advertising of particular products.

(34) The question of publishing the address on "Dust Hazards" by Dr. Frederick Willson was discussed, and it was recommended without vote that this paper be submitted for approval to members of the Board before publishing.

(35) Program for the Materials and Equipment Division was presented briefly by Mr. Kelsey more for information than for action. Mr. Kelsey's statement is appearing in the April *Bulletin*, p. 98.

(36) Mr. Eskesen brought up the question of local committee organization and of publicity for our Annual Meetings. This was discussed at some length without action being taken.

Mr. McAfee assured the Board that publicity arrangements would be provided in connection with the Pittsburgh Meeting before, during, and immediately following the Meeting.

(37) The Secretary was instructed to draw up Resolutions in memory of LeRoy H. Minton, said Resolutions to be published in the *Bulletin*, and a suitable transcript of them to be sent to Mrs. Minton. The Resolutions are as follows:

LeRoy H. Minton, Resolutions by Board of Trustees, American Ceramic Society

On December fifteenth, nineteen hundred and thirty-one, LeRoy H. Minton was taken suddenly from his mundane activities to his heavenly reward.

He gave his time, energies, and talents lavishly for his family, friends, church, lodge, and community. He gave liberally to the AMERICAN CERAMIC SOCIETY as a committeeman, trustee, and president. He also added in a large way to the SOCIETY's records of original research reports.

As a promoter, advisor, leader, and literature contributor; as a lovable, happy comrade, LeRoy H. Minton will be greatly missed by the members of the AMERICAN CERAMIC SOCIETY.

WHEREAS, This SOCIETY, of which we are the elected Board of Trustees, has suffered a loss inestimable, we realize that to his beloved wife and children the loss is even greater and more intimate; and

WHEREAS, His work and contacts in this SOCIETY were made richer because of the loving coöperation he had in his own family circle:

Be It Resolved, That we, the Board of Trustees, in the name of and for the members of the AMERICAN CERAMIC SOCIETY, transmit to the wife and children of LeRoy H. Minton our sincere gratitude for all that he was and for all that he accomplished for this SOCIETY, and that we express our profound sympathies for the loss which they have sustained.

BOARD OF TRUSTEES,
AMERICAN CERAMIC SOCIETY,
FEBRUARY ELEVEN,
NINETEEN HUNDRED THIRTY-TWO,
WASHINGTON, D. C.

(38) President Poste announced that he would call an Executive Committee Meeting in Columbus on April 8, to which members of the Board will be invited.

REPORT OF COMMITTEE ON PUBLICATIONS

The Publications Committee submits the following report of the activities of the Committee for the year ending February, 1932.

Six bids on contracts for SOCIETY publications were reviewed. The contract was relet to the Mack Printing Company, both on account of the relative amount of the bid and on the basis of the high degree of satisfactory service received from this company in the past. This contract represents an estimated saving of about $500 over the previous contract.

The Committee agreed to engage in exchange of publications with the International Information Bureau of Scientific Research in Building Industry for its *Index* and *Notes Periodiques*. This agreement is to be in effect for one year.

The policy of simultaneous publication of articles in the *Journal of the American Ceramic Society* and elsewhere was reviewed by the Committee. An investigation was made of the policies of other technical societies regarding disposition of such papers. This matter was thoroughly reviewed by the members of the Publications Committee preceding the summer meeting on September 12 at Old Point Comfort, Va.

The meeting of the Committee at Old Point Comfort was called to consider action on publication policies as mentioned above. The action taken at this meeting was published.*

Considerable miscellaneous correspondence with different Division representatives was exchanged pertaining to the explanation of the resolutions adopted.

The Publications Committee decided to leave the disposition of the papers submitted for presentation at the February, 1932, Meeting of the SOCIETY in the hands of the program committees of the separate Divisions.

The Publications Committee again desires to go on record favoring the action on Resolution II, which is as follows:

A resolution was therefore made and passed to the effect that the Committee on Publications advises each Division of the SOCIETY to form and organize a Division Publications Committee; and that these Division Publications Committees shall draw up uniform operating rules for their guidance.

J. T. LITTLETON, *Chairman*
L. J. TROSTEL
LOUIS NAVIAS
A. E. R. WESTMAN

Meeting in Washington

A dinner meeting of the Committee on Publications was held on the evening of February 9 at the Willard Hotel, Washington, D. C. The following members were present: J. T. Littleton, chairman, and Louis Navias, secretary *pro tem*. The Divisions were represented by the following persons: Glass, J. T. Littleton; Refractories, D. W. Ross; Enamel, E. P. Poste; White Wares, E. Schramm; and Structural Clay Products, Howells Fréchette.

(1) The minutes of the September meeting were read.

(2) Dr. Littleton stressed the necessity of an editorial committee for each Division and it was agreed that a notice be prepared by the Chairman asking that each Division make immediate plans to set up an editorial committee.

(3) The misunderstanding of the Resolution I (September, 1931) was discussed by Dr. Littleton, who brought out the following points:

(*a*) Powers had been delegated to the Chairman of the Program Committees regarding material presented before them at meetings and regarding their desire to hold the material for publication.

* See *Bull. Amer. Ceram. Soc.*, **10** [12], 345–46 (1931).

(*b*) Reprinting of papers can be indulged in by Bureaus and other organizations, provided acknowledgment is made to the SOCIETY.

(4) Mr. Purdy indicated how this policy would affect certain publications.

(5) Mr. Purdy brought up the resolution of the Finance Committee of the SOCIETY bearing on the publication of the *Journal* as follows: (*a*) cut out all free reprints; (*b*) eliminate patent abstracts as at present given and list patents by title only; and (*c*) reduce cost of illustrations in the *Journal* wherever possible by having the authors provide the necessary drawings made up using specifications laid down by the Secretary's office.

(6) Dr. Sharp suggested that due to the difficulty of obtaining foreign patents (Resolution (5*c*)) as above be restricted to domestic patents only. Mr. Purdy indicated that this matter would be considered by the Finance Committee.

(7) Mr. Fréchette suggested as a means of economy the limiting of material presented at meetings. It was decided that this matter should be cared for by the individual Division Program Committees.

(8) While no vote was taken on item (5), the discussion indicated that the group was in sympathy with the suggestions of the Finance Committee. Item (6) was the only comment leading to discussion in this connection.

(9) The meeting adjourned at 8 P.M.

LOUIS NAVIAS, *Secretary pro tem*

MINUTES OF MEETING OF THE MATERIALS AND EQUIPMENT DIVISION

The meeting of the Materials and Equipment Division of the AMERICAN CERAMIC SOCIETY was held on February 9, 1932, in Washington, D. C., Henry Kleinfeldt, acting chairman.

After opening this meeting Mr. Kleinfeldt reviewed briefly the aims and purposes of the Materials and Equipment Division and the relationship of this Division to the AMERICAN CERAMIC SOCIETY at large.

In the absence of C. H. Peddrick, Chairman of the Membership Committee, his report was read and made a part of the record. H. B. DuBois, Chairman of the Nominating Committee, was asked to defer reading his report until the following day.

The report of the Secretary and Treasurer was not read at this meeting but it was agreed that this report be written up and mailed to each member of the Materials and Equipment Division.

Another meeting of the Materials and Equipment Division was heid on February 10 and thirty members were in attendance. At this meeting a great deal of enthusiasm was manifested by everyone and the following matters were discussed:

The dance sponsored by the Materials and Equipment Division on Tuesday evening, February 9, at the Washington Hotel was attended by more than four hundred and fifty people. This informal affair has done more to strengthen the position of the Materials and Equipment Division than perhaps any other single transaction.

Mr. Kleinfeldt, in opening the meeting, took pleasure in expressing the universal acceptance of the members of the SOCIETY in connection with the dance and again outlined the plans and purposes of the Materials and Equipment Division.

The report of the Nominating Committee was read by Mr. DuBois and it was moved by Mr. Crane that the present officers be elected by acclamation to succeed themselves, with the exception that Henry Kleinfeldt be elected Chairman in lieu of L. E. Riddle, Jr., who asked to be relieved as Chairman of the Division. This motion was carried.

Mr. Peddrick's report as Chairman of the Membership Committee was read and approved and he pointed out in his report that during the year he was successful in reducing the deficit by $165.

Mr. Burgess stated that the future success of this Division depends quite largely on the type of papers that are presented to the members of the SOCIETY at large. With this in mind Professor Brown was appointed Chairman of the committee to solicit papers and to accept such papers as, in the opinion of his committee, would be interesting and suitable to present at the Annual Meeting of the AMERICAN CERAMIC SOCIETY.

On motion by Mr. Metz, which was unanimously carried, a luncheon of the Materials and Equipment Division members is to be held on the first day of the Annual Meeting.

Professor Brown suggested that a letter be sent to the entire membership of the AMERICAN CERAMIC SOCIETY calling attention to the fact that each member has the privilege of holding membership in more than one Division. Professor Brown also stated that it might be arranged for a division of funds in the case where a member holds membership in more than one Division.

It was proposed that the Materials and Equipment Division secure permission from the SOCIETY to hold one general meeting at the Annual Meeting, at such time and place as would not interfere with the SOCIETY meetings; this meeting to be a general session under the supervision of the Materials and Equipment Division. It is hoped that this can be accomplished. The foregoing was put in the form of a motion by Mr. Dressler and was seconded and carried.

On motion by Mr. Burgess, which was carried, it was agreed to send a letter to the members asking for certain limited contributions, in order to wipe out the present deficit of approximately $450. In this letter plans will be outlined, describing the aims and purposes of the Materials and Equipment Division.

On motion by Mr. Metz, which was carried, it was agreed that the Materials and Equipment Division will hold an annual dance and frolic for the entire membership, if this plan will not interfere with the plans of the SOCIETY at large.

V. V. KELSEY, *Secretary*

MINUTES OF MEETING OF THE REFRACTORIES DIVISION*

The business session of the Refractories Division was held immediately following the Thursday morning technical session. The meeting was presided over by the Vice-Chairman, S. M. Phelps, in the absence of A. E. R. Westman, Chairman, whose attendance was prevented by illness in his family.

On account of the recent death of R. B. Gilmore, a committee was appointed, consisting of C. E. Bales and L. J. Trostel, this committee to prepare Resolutions to be presented to Mrs. Gilmore, expressing the sympathy of the members of the Refractories Division.

A communication from Dr. Westman was read, in which were outlined the Division's activities during the year 1931, having special reference to the able work of the Program and Publications Committees.

Reports of the Chairmen of the Divisional committees and Division representatives were given.

A motion was made by F. A. Harvey, which was regularly seconded and carried, that a letter ballot be submitted to members of the Division to obtain a vote as to whether the technical sessions should be confined to a two-day period rather than the present three-day period.

* Held at Washington, D. C., February 11, 1932.

C. E. Bales made an additional motion, seconded and carried, that in the same ballot the members express their preference to having a Division dinner, at which time the Division's business meeting would be held, or whether this business should be transacted at the close of one of the technical sessions.

The report of the Nominating Committee was submitted and, there being no further nominations from the floor, the following persons were duly elected to office:

Trustee: J. M. McKinley
Chairman: S. M. Phelps
Vice-Chairman: R. A. Heindl
Secy.-Treas.: H. E. White
Chairman Program Committee, R. B. Sosman

H. E. WHITE, *Secretary*

THE 1933 ANNUAL MEETING

Pittsburgh is the city; William Penn, the hotel; the week of February 12, 1933, the time.

Henry Ford is betting three hundred million dollars that 1932 will see the return of normal business. Other far-seeing men are wagering on the return of prosperity.

These men are doing more than wagering their cash and their resources; they are doing things that will help bring better business; they are thinking, doing, and investing in their confidence that business will pick up.

Wars are won by aggressive, offensive tactics. Defensive warfare never succeeded. This is true in all human activities, in love, in culture, in business, in religion, and in the affairs of this SOCIETY.

Committees are planning for the 1933 Meeting aggressively in the same sort of spirit that prompts Ford's gamble on prosperity.

The Pittsburgh Section, Hobart Kraner, Chairman, and a special meeting committee, Alexander Silverman, Chairman, have their plans well formulated and under way. Watch their announcements and prepare to do your part.

LOCAL SECTION NEWS

Pacific Northwest Section[1]

A meeting of the Pacific Northwest Section of the American Ceramic Society was held at the University of Washington, Feb. 27, 1932.[2] The following officers were elected for 1932:

President: G. L. Rogers, Gladding, McBean & Co., Seattle, Wash.
Vice-President: H. R. Kreitzer, Columbia Brick Works, Portland, Ore.
Councillor: S. Geijsbeek, Geijsbeek Engineering Co., Seattle, Wash.
Treasurer: H. O. Thompson, Builders Brick Co., Seattle, Wash.
Secretary: Hewitt Wilson, University of Washington, Seattle, Wash.

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[1] Hewitt Wilson, *Secretary.*
[2] For program see *Bull. Amer. Ceram. Soc.*, 11 [3], 74 (1932).

Samples of salt-glazed and terra cotta-glazed building tile made by the Washington Brick Lime and Sewer Pipe Co. were exhibited by Mr. Coleman of that company, and new road-marking tile made of white clay from Willamina, Ore., were shown by H. G. Wilcox of the Willamina Clay Products Co.

Two papers which were not on the program were read, *viz.*, "The New Harrop Railroad Tunnel Kiln at the Stockton Fire Brick Co., Pittsburgh, Calif.," by M. E. Reynolds, and "University Life at the University of Prague," by Nicholas Mara.

The members attending the meeting were as follows: Geo. H. Krueger, Hewitt Wilson, G. L. Rogers, V. L. Nielsen, Arthur Houlahan, Milnor Roberts, Willis E. Clark, S. Geijsbeek, M. E. Reynolds, W. J. Howard, Joseph Daniels, W. E. Coleman, Jim Hannock, Harold MacDonald, Kenneth G. Skinner, F. T. Houlahan, W. F. Walthall, and Norman L. Field of Seattle, Wash.; L. A. Martin, J. C. Hoskins, C. A. Ohlin, H. B. Lemley, and Wurth Kriegel of Renton; W. E. Lemley of Taylor; T. Miller, E. Davies, T. E. Nicholson, Fred Kettenring, Jr., and E. J. Nelson of Auburn; Thad O. Smith of Ravensdale.

NECROLOGY

J. L. Murphy

Funeral services for Joseph Lincoln Murphy, 2756 E. Broad Street, prominent brick and clay products manufacturer, who died suddenly from heart disease at his home on February 20, 1932, were held in Columbus, Ohio, Tuesday, February 23.

Mr. Murphy dropped dead in the kitchen of his home. He was 55 years old. Since his return a week before from the Paving Brick Manufacturers Association convention in Chicago, he had been suffering from acute indigestion. He was confined to his bed for several days. On Saturday afternoon he started out for a short walk. He returned a few minutes later and entered the house by the kitchen door. As he stepped inside he dropped dead.

J. L. Murphy

Had Many Interests

Mr. Murphy, who was familiarly known as "Pat" among his friends and associates was president of the Hocking Valley Brick Co., Logan; president of the Nelsonville Brick Co., Nelsonville; president of the Zanesville Clay Products Co., Zanesville; vice-president of the Ohio Fireproofing Co., Nelsonville; chief engineer for the New York Coal Co., Columbus, and held minor offices in other of the Poston interests.

He also was chairman of the Executive Committee of the Ohio Paving Brick Manufacturers Association.

Born in Vinton County

Mr. Murphy was born in Valeski, Vinton County, and until he was 14 could not read or write. At that age he began doing odd jobs for a doctor in McArthur. He started to school and completed 12 years of public school work in eight years.

He entered Ohio State University at the age of 22 in 1899 and worked as a street car conductor at nights to earn his expenses. He graduated with honors as a civil engineer in 1903.

He is survived by his widow, Mrs. Margaret Duvall Murphy, formerly of Zanesville.

Active in Ceramic Organizations

Mr. Murphy was also an active member of the AMERICAN CERAMIC SOCIETY, the Ohio Ceramic Industries Association, the National Paving Brick Manufacturers Association, the Structural Clay Tile Association, the Common Brick Manufacturers Association, the Clay Products Association, and the Clay Products Institute.

A Worker for Coördinated Efforts

Pat Murphy, on all appropriate occasions, spoke and worked for a closer coördination and coöperation in association work. He stood solidly for a federation of ceramic interests. He gave a large amount of his time and money in an effort to interest the several ceramic groups to unite in a big ceramic exhibit at the Chicago Century of Progress Exposition in 1933.

Pat Murphy was among the first who was approached by the Secretary of the AMERICAN CERAMIC SOCIETY on the organization of a ceramic association in Ohio for the purposes of (1) to secure ceramic research in the Ohio State University Engineering Experiment Station under the direction of a research professor, (2) to negotiate the purchase by the State of a brick plant in Roseville, and to establish in connection therewith a laboratory for plant proving of research results, (3) to secure the establishment at Ohio State University of a department of instruction in ceramic art, (4) to secure Federal and State aid in establishing ceramic instruction in high schools, and ceramic extension instruction in ceramic centers in Ohio, and (5) to build up a historical ceramic exhibit in the Ohio State Historical Society Museum.

To these several projects Mr. Murphy gave constant and effective support, and he was the one most largely responsible for their ultimate realization. Without his adroitness and convincing personality, it would have been impossible for the Secretary of this SOCIETY to secure the withdrawal of the several injunctions against the State purchase of the Roseville brick plant, to convince the University of the value of the several projects recommended, and to persuade Dr. George A. Bole to accept the Ceramic Research Professorship and Secretaryship of the Ohio Ceramic Industries Association. This Association was formed, all of the objectives were attained, and the entire program placed on such a sound basis that the whole scheme is being carried on with increasing effectiveness. It was no small task to obtain and to hold the support for this Ohio Ceramic Industries Association program, and to Mr. Murphy belongs a large part of the credit for the success obtained in the beginning and which has continued.

Professor Harry Nold, the present Secretary of the Ohio Ceramic Industries Association, says in his monthly membership letter of Mr. Murphy:

> Mr. Murphy was one of the founders of the Ohio Ceramic Industries Association and has ever since been one of our most interested and active members. As chairman of the "Public Relations" Committee he was a cheerful, efficient, and indefatigable worker. No piece of work for the Association was either too small or too large for him to undertake and complete promptly. His tact and ability to get things done have been a big factor in the success of the many Association projects.

A similar testimony could be given by each of the several ceramic associations in which Mr. Murphy had membership. In the death of Mr. Murphy the AMERICAN CERAMIC SOCIETY has lost another leader and a consistent worker. The Secretary of this SOCIETY has lost a valued, often-sought councilor and supporter.

DeWitt F. Riess

DeWitt F. Riess, vice-president of the Vollrath Company of Sheboygan, Wisconsin, died suddenly of heart attack in a Chicago hotel on January 8, 1932. Mr. Riess was born in Sheboygan in 1886. After his graduation from the Sheboygan high school he attended the University of Wisconsin for several years. Upon the death of his father in 1906 he became associated with the Vollrath Company, of which his father had been secretary and treasurer. In 1916 Mr. Riess became a member of the AMERICAN CERAMIC SOCIETY and was actively identified with its interests and growth from that date. His firm has also carried a corporation membership for many years.

Mr. Riess was civic-minded to an unusual degree and was closely identified with many worthy projects in his home city. He was a generous contributor to all philanthropic causes and his private charities were many.

DEWITT F. RIESS

Gustav von den Steinen

Mr. von den Steinen, a member of the AMERICAN CERAMIC SOCIETY since 1925, died in Cleveland on December 5 1931. He was vice-president of the Glascote Co. of Euclid, Ohio.

RESOLUTIONS ON THE DEATH OF RAYMOND B. GILMORE

The Refractories Division of the AMERICAN CERAMIC SOCIETY in regular session during the Annual Meeting at Washington, D. C., on February 9, 1932, unanimously adopted the following Resolutions:

WHEREAS, Our esteemed friend and business associate, Raymond B. Gilmore, has been taken from us, and

WHEREAS, By his personality, knowledge, and technical activities he has proved a valuable member of the AMERICAN CERAMIC SOCIETY, as evidenced by his being Vice-Chairman of the Refractories Division, and

WHEREAS, He was a true and loyal friend to every member of this Division,

Therefore Be It Resolved, First, that we gratefully acknowledge the influence his life has exerted on our industry and in the Refractories Division of the AMERICAN CERAMIC SOCIETY.

Second, that we feel deeply the great loss we have sustained in the death of our friend and co-worker.

Third, that we extend to the bereaved family our sincerest sympathy.

Fourth, that a copy of these Resolutions be sent to his wife and family.

Fifth, that a copy of these Resolutions be placed in the permanent records of the Refractories Division.

PERMANENT CERAMIC EXHIBIT

This SOCIETY is collecting a notable permanent exhibit of ceramic products, tools, and trophies. These are displayed in the executive offices at 2525 N. High Street, Columbus. Additions to this collection have been reported from time to time. There were two additions last month.

(1) Lenox, Incorporated, Trenton, N. J., has added to its exhibit, sending six plates, several dishes, cups and saucers, all of Belleek china, and all beautifully decorated.

(2) The banners and flags of the National Brick Manufacturers Association, which year after year Theodcre A. Randall brought to the meetings of that Association, have been sent to the SOCIETY headquarters for display and preservation. As mementos of an Association that for a half-century served the brick and tile interests by promoting investigations, by providing meetings, by developing brotherhood among business competitors, and by recording informational data and facts, these banners will be cherished.

It was at a meeting of the National Brick Manufacturers Association thirty-five years ago in the Monongahela House, Pittsburgh, that Samuel Geijsbeek conceived the idea of a select group who could gather for the purpose of discussing understandingly the technical and scientific problems in ceramics. Sam held a Section Q Meeting—ah, those occasions—and Professor Orton volunteered to effect a separate organization for this group. The AMERICAN CERAMIC SOCIETY was the result. This SOCIETY, therefore, has a family pride in the official insignia of the National Brick Manufacturers Association.

NOTES AND NEWS

DEPARTMENT OF GLASS TECHNOLOGY AT ALFRED UNIVERSITY

The New York Legislature, in approving the budget prepared by the trustees of Alfred University and submitted by the Governor, has provided for a department of glass technology under a professor to be elected in April. This marks the first establishment of formal education and research in glass technology in America.

The Legislature also approved changing the name of the ceramic school to "The New York State College of Ceramics at Alfred University."

CERAMIC ENGINEERING FRATERNITIES MERGE

After negotiations covering the past two years Keramos and Beta Pi Kappa fraternities agreed to merge into one organization under the name "Keramos." The name is the Greek word for ceramics.

Both organizations had the same objectives of binding together the ceramic graduates of the departments of ceramic engineering throughout the country and promoting their interests after graduation. Both fraternities elected only the outstanding students to membership.

Beta Pi Kappa was founded at Ohio State University in 1902 only a few years after the department there was established by General Edward Orton, Jr., and the AMERICAN CERAMIC SOCIETY was founded. The Ohio State chapter became dormant some years ago but active chapters were located at North Carolina State College and Alfred University.

Keramos was founded at the University of Illinois in 1915 and had active chapters at the University of Illinois and Ohio State University.

Although both organizations have had high scholarship and attainment requirements for admission, the new organization has adopted even higher standards. While many employers of ceramic graduates had come to accept membership in either Keramos or Beta Pi Kappa as a recommendation, the new fraternity proposes to maintain its standard on a plane that will be a practical guarantee that its members are among the elect in scholarship, character, and attainment.

The national officers of the fraternity are as follows:

Grand President: A. F. Greaves-Walker, North Carolina State College, Raleigh, N. C.
Grand Vice-President: G. A. Bole, Ohio State University, Columbus, Ohio
Grand Secretary: Ralph K. Hursh, University of Illinois, Urbana, Ill.
Grand Treasurer: Charles F. Binns, Alfred University, Alfred, N. Y.
Grand Herald: A. S. Watts, Ohio State University, Columbus, Ohio

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CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science		
Summer Meeting	June 20–25	Syracuse, N. Y.
Winter Meeting	December 27–31	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY	February 12–18, 1933	Pittsburgh, Pa.
American Foundrymen's Assn.	May 2–6	Philadelphia, Pa.
American Gas Assn.	October 10–16	Atlantic City, N. J.
American Institute	May 5	New York, N. Y.
American Institute of Chemical Engineers	June 15–17	Schenectady and Corning, N. Y.
American Refractories Institute	May	Pittsburgh, Pa.
American Society of Mechanical Engineers	June 27–30	Huntsville, Ont.
American Society for Steel Treating	October 3–9	Buffalo, N. Y.
American Society for Testing Materials	June 20–24	Atlantic City, N. J.
Association of Iron and Steel Electrical Engineers	June 20–23	Pittsburgh, Pa.
Electrochemical Society	April 21–23	Baltimore, Md.
Exposition of Chemical Industries	February 27–March 4, 1933	New York, N. Y.
National Assn. of Stove Manufacturers	May 8–13	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 6–8	New York, N. Y.
National Safety Council	October 3–7	Washington, D. C.
New Jersey Clay Workers Assn.	June	Asbury Park, N. J.
Scientific Apparatus Makers of America	May	Wernersville, Pa.
Taylor Society, Inc.	December 7–9	New York, N. Y.

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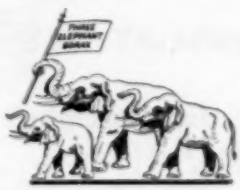

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